[redacted] NON-REGISTERED

INSTRUCTION BOOK

FOR

NAVY MODEL
SO-1
RADAR EQUIPMENT

SHIPS 238

MANUFACTURED FOR

U. S. Navy Department — Bureau of Ships

BY

RAYTHEON MANUFACTURING COMPANY
WALTHAM, MASSACHUSETTS
U. S. A.

Contracts NXss-15362, NXss-33645

AUTH: JANP 140

Copy 2

[redacted] UNCLASSIFIED NON-REGISTERED

INSTRUCTION BOOK

FOR

NAVY MODEL
SO-1
RADAR EQUIPMENT

SHIPS 238

This document contains information affecting the National Defense of the United States within the meaning of the Espionage ACT (U.S.C. 50: 31, 32). The transmission of this document or the revelation of its contents in any manner to any unauthorized person is prohibited.

This Instruction Book is furnished for the information of commissioned, warranted, enlisted and civilian personnel of the Navy and persons authorized by the Bureau of Ships whose duties involve design, manufacture, instruction, operation, and installation of radio, radar, or underwater sound equipment. The word **"Confidential"** as applied to this instruction book signifies that it is to be read only by the above personnel, and that its contents should not be made known to unauthorized persons not connected with the Navy.

MANUFACTURED FOR

U. S. Navy Department—Bureau of Ships

BY

RAYTHEON MANUFACTURING COMPANY
WALTHAM, MASSACHUSETTS
U. S. A.

Contracts NXss-15362, NXss-33645

PROMULGATING LETTER

1. SHIPS 238 is a confidential non-registered publication and shall be handled, transported, and safeguarded in accordance with U.S. Naval Regulations and the current edition of the Registered Publications Manual. Periodic accounting is not required.

2. IT IS FORBIDDEN TO MAKE EXTRACTS FROM OR TO COPY THIS PUBLICATION WITHOUT SPECIFIC AUTHORITY FROM THE CHIEF OF THE BUREAU OF SHIPS, EXCEPT AS PROVIDED FOR IN ARTICLE 516 OF THE REGISTERED PUBLICATIONS MANUAL.

3. Enlisted and warrant personnel whose duties require its use should have access to this publication. Civilian employees of the Navy and employees of contractors whose duties require its use should also have access to this publication.

4. SHIPS 238 replaces the Tentative SO-1 Instruction Book and upon receipt hereof, the Tentative SO-1 Instruction Book shall be destroyed. No report of such destruction is required.

DANGER—High Voltages

Operation of this equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors, etc. To avoid casualties, always remove power, discharge and ground circuits prior to touching them.

RECORD OF CORRECTIONS

Change No. or Reg. Publ. Memo.	Entered By	Date

TABLE OF CONTENTS

[Quick access to the ten main sections of this book is provided by a system of marginal index tabs. The tabs for all ten sections are combined in a strip on the edge of the opposite page. To find a section, open the book to this index page and note the vertical position of the tab for the desired section. Then look at the edge of the book and turn to the pages whose tabs are in line with the tab on the index strip.]

SUB-SECTION

SECTION 1 — DESCRIPTION

PAGE

Introduction 1
1.0 Functional Operation 1
1.1 List of Included Units 5
1.2 Location of Components 7
1.3 Cabling Designations 8
1.4 Physical Characteristics 8

SECTION 2 — INSTALLATION

2.1 Power Requirements 11
2.2 Installation Layout Plans 11
2.3 Housings and Supports 11
2.4 Installation Requirements 11
2.5 Cabling and Connections 13
2.6 Tubing of Equipment 14
2.7 Check-up Following Installation 14
2.8 Elimination of Interference 15

SECTION 3 — OPERATION

3.0 General 17
3.1 Starting the Equipment 17
3.2 Operating Adjustments 18
3.3 Determining Range and Bearing 18
3.4 Emergency Operation 20
3.5 Minor Operating Controls 21
3.6 Use of Resonance Chamber 22
3.7 Calibrating the Accessory Control Unit 22
3.8 Notes on Operation 23
3.9 List of Controls and Adjustments 24

SECTION 4 — MAINTENANCE AND SERVICE

4.1 Preventive Maintenance 27
Routine Maintenance Table 30
4.2 Locating Trouble 27
Voltage Measurements 32
Test Point Locations 34
Fuse Locations 38
Quick Check-up After Equipment Failure 27
Locating Faulty Units 39
Locating Faulty Components 40
Miscellaneous Symptoms of Failure 40
4.3 Maintenance Instructions (arranged by units) 41
Motor Alternator 41
  General 41
  Bearings and Electrical Contacts (Leland and Murray) 41
  Early-Type Spark Gap (CRP-10212) 41
  Basic Spark Gap (CRP-10249) 45
  Speed Regulator 49

SUB-SECTION PAGE

Modulator and Voltage Regulator . . . 50
Transmitter-Receiver . . . 52
Rectifier Power Unit . . . 59
Plan Position Indicator . . . 59
Antenna Assembly . . . 61
Miscellaneous . . . 67

SECTION 5 — MOTOR-ALTERNATOR-MODULATOR

5.0 General . . . 75
5.1 Drive Motor and Magnetic Controller . . . 76
5.2 Speed Regulator . . . 76
5.3 Exciter Generator . . . 78
5.4 Alternator . . . 80
5.5 Electronic Voltage Regulator . . . 80
5.6 Modulator . . . 82

SECTION 6 — TRANSMITTER

6.0 General . . . 85
6.1 Pulse Transformer . . . 86
6.2 Pulse Modulation . . . 86
6.3 Operation of the R.F. System . . . 88
6.4 Theory of Waveguides and Resonant Cavities . . . 89
6.5 Theory of the R.F. System . . . 90

SECTION 7 — RECEIVER

7.0 General . . . 93
7.1 Local Oscillator Adjustments . . . 93
7.2 Local Oscillator Theory . . . 94
7.3 Input Circuit and Crystal Mixer . . . 95
7.4 Intermediate Frequency Amplifier . . . 95
7.5 Demodulator (Second Detector) and Video-Limiter . . . 97
7.6 Rectifier Power Unit . . . 97

SECTION 8 — INDICATOR

8.0 General . . . 99
8.1 Video Amplifier . . . 101
8.2 Square-Wave Multivibrator . . . 102
8.3 Sweep Generator and Amplifier . . . 104
8.4 Marker Oscillator . . . 105
8.5 Marker Amplifiers and Sharpeners . . . 105
8.6 PPI Tube . . . 106
8.7 Power Supplies . . . 108
8.8 IFF Control Unit and Line Voltmeter . . . 109

SECTION 9 — ANTENNA

9.0 General . . . 111
9.1 Drive Mechanism . . . 111
9.2 Synchro System . . . 111
9.3 True-Bearing Systems . . . 113
9.4 Theory of Antenna Radiation . . . 115
9.5 Resonance Chamber . . . 118
9.6 Junction Box . . . 119

SECTION 10 — ACCESSORY CONTROL UNIT

General . . . 121

1 Description
2 Installation
3 Operation
4 Maintenance and Service
5 Motor-Alternator-Modulator
6 Transmitter
7 Receiver
8 Plan Position Indicator
9 Antenna
10 Accessory Control Unit

LIST OF ILLUSTRATIONS

FIGURE		PAGE
1A	Transmission of R.F. Energy	3
1B	Reception of Echoes from Target	3
2	Basic Functional Operation	4
3	Block Diagram	6
4	Typical SO-1 Installation on LST Craft	10
5	Lug Protected by Spaghetti	13
6	Boot Drainage Hole	14
7	Accessory Control and Indicator Units: control panels	16
8	Signals as Seen on PPI Screen	18
9	Bearing Control Unit	19
10	IFF Control Unit and Line Voltmeter	21
11	Tuning with Resonance Chamber (echo box)	22
12	Accessory Control Unit Mounted in Cradle over Plan Position Indicator	26
13	Servicing Block Diagram: main equipment	28
14	Servicing Block Diagram: A.C.U.	37
15	Motor-Alternator-Modulator with Spark Gap CRP-10212	42
16	Motor-Alternator-Modulator with Spark Gap CRP-10249	42
17	Motor-Alternator-Modulator: spark gap details	43
18	Motor-Alternator-Modulator: spark gap skeleton	43
19	Motor-Alternator-Modulator: spark gap assembly	44
20	Basic Spark Gap	46
21	Basic Spark Gap	47
22	Basic Spark Gap: spacing adjustment	47
23	Basic Spark Gap: typical timing marks	48
24	Basic Spark Gap: normal oscilloscope waveforms	48
25	Speed Regulator	49
26	Motor-Alternator-Modulator: voltage and speed regulator adjustments	50
27	Motor-Alternator-Modulator: terminals	51
28	Motor-Alternator-Modulator: voltage regulator chassis open	51
29–35	Magnetron Replacement	53
36	TR Box (Duplexing Cavity)	55
37	Local Oscillator (McNally) Tube and Cavity	56
38	Transmitter-Receiver: tr box and local oscillator	57
39	Replacement of PPI Tube	60
40	Antenna CRP-66AFL: flasher switches	62
41	Antenna CRP-66AFL: cover open	63
42	Antenna CRP-66AFL: differential removed	63
43	Antenna CRP-66AGE: details	64
44	Antenna CRP-66AGE	65
45–49	Assembly Procedures for Terminal Tubes and Cables	69
50	Special Tools Included in Equipment Spares	74
51	Motor-Alternator-Modulator: modulator side	75
52	Magnetic Controller and Start-Stop Push Button Switch	77
53	Magnetic Controller: chassis	78
54	Motor-Alternator-Modulator with Spark Gap CRP-10212	79
55	Motor-Alternator-Modulator with Basic Spark Gap CRP-10249	79
56	Electronic Voltage Regulator (schematic)	81
57	Motor-Alternator-Modulator: spark gap and modulator (schematic)	82

FIGURE PAGE

58 Tail-Clipping Action 82
59 Motor-Alternator-Modulator: modulator compartment open 83
60 Motor-Alternator-Modulator: modulator and voltage regulator compartments open 84
61 Transmitter-Receiver: access door 85
62 Transmitter-Receiver Unit 85
63 Transmitter-Receiver (cover removed): magnetron side 86
64 Magnetron Oscillator (schematic) 87
65 Transmitter-Receiver (cover removed): receiver side 87
66A Low-Frequency Analogy of R.F. System 88
66B R.F. Assembly 88
67 Development of Waveguide 89
68 Development of Cavity 89
69 Transmitter-Receiver: underside 91
70 Receiver Strip 92
71 Receiver Strip: underside 92
72 Receiver: local oscillator (schematic) 93
73 Receiver: local oscillator tube and cavity 94
74 Receiver: cross section of mixer 95
75 Receiver: first and second i.f. stages (schematics) 96
76 Receiver: second detector (demodulator) and video-limiter (schematic) 96
77 Rectifier Power Unit 97
78 Rectifier Power Unit: chassis (early type) 97
79 Receiver Power Unit: chassis (late type) 98
80 Rectifier Power Unit: underside 98
81 Rectifier Power Unit: terminal strips exposed 98
82 Plan Position Indicator Unit 99
83 Plan Position Indicator: top view of chassis 100
84 Plan Position Indicator: underside of chassis 101
85 Plan Position Indicator: video amplifier (schematic) 102
86 Plan Position Indicator: square-wave multivibrator (schematic) 103
87 Plan Position Indicator: sweep generator and amplifier (schematic) 104
88 Plan Position Indicator: marker oscillator (schematic) 105
89 Plan Position Indicator: marker amplifiers and sharpeners (schematic) 105
90 Plan Position Indicator: PPI assembly (schematic) 107
91 Plan Position Indicator: PPI assembly 107
92 Plan Position Indicator: 7-kv. power supply (schematic) 108
93 Plan Position Indicator: terminals at rear of case 108
94 Plan Position Indicator: 300-volt power supply (schematic) 109
95A IFF Control Unit and Line Voltmeter 110
95B IFF Control Unit: interior 110
96 Antenna CRP-66AFL 112
97 Antenna CRP-66AFL 112
98 Antenna CRP-66AGE 113
99 Antenna CRP-66AGE 114
100 Antenna CRP-66AFL: cross section of r.f. shaft 115
101 Antenna CRP-66AFL: horizontal radiation pattern 116
102 Antenna CRP-66AGE: horizontal radiation pattern 117
103 Resonance Chamber Installed 118
104 Junction Box 119
105 Accessory Control Unit: front panel 121
106 Accessory Control and Indicator Units: rear view 122

MAIN SCHEMATICS AND ASSEMBLY DRAWINGS

(Following Section 10)

Model SO-1 — W-4-W4 sub F External Cabling (CRP-66AFL Antenna Only)

Model SO-1 — W-4-W2 sub A External Cabling Including True Bearing and A.C.U. (CRP-66AFL Antenna Only)

Model SO-1 — W-4-W6 sub A External Cabling (CRP-66AGE Antenna Only)

Model SO-1 — W-4-W5 sub A External Cabling Including True Bearing and A.C.U. (CRP-66AGE Antenna Only)

Model SO-1 — W-4D-W132 sub H Motor-Alternator-Modulator (early type)

Model SO-1 — W-4D-W132 sub S Motor-Alternator-Modulator (later type using Leland Motor)

Model SO-1 — W-4D-W213 sub L Motor-Alternator-Modulator (using Murray Motor)

Model SO-1 — W-4D-U32 sub G Leland Motor-Alternator: Color Coding

Model SO-1 — W-4D-U197 sub C Murray Motor-Alternator: Color Coding

Model SO-1 — W-4D-L151 sub E Motor-Alternator: Voltage Regulator

Model SO-1 — W-4D-U164 sub A Motor-Alternator: Z-104 Noise Filter

Model SO-1 — W-4D-V117 sub F Magnetic Controller

Model SO-1 — Primary D. C. Circuit

Model SO-1 — W-4F-V1 sub B Rectifier Power Unit (early type)

Model SO-1 — W-4F-V1 sub E Rectifier Power Unit (later type)

Model SO-1 — W-4B-U2 sub E Transmitter-Receiver

Model SO-1 — W-4B2-V5 sub G Receiver

Model SO-1 — W-4E1-V119 sub A Junction Box

Model SO-1 — W-12A1-V140 sub D Antenna CRP-66AFL

Model SO-1 — W-14A1-V296 sub I Antenna CRP-66AGE

Model SO-1 — W-3C-W328 sub E Plan Position Indicator (early type)

Model SO-1 — W-3C-W328 sub O Plan Position Indicator (later type)

Model SO-1 — W-2-5212 sub 3 Indicator: External Cabling

Model SO-1 — W-3K22-W204 sub J Accessory Control Unit

Model SO-1 — W-30A1-U5 sub E IFF Control Unit and Line Voltmeter

SAFETY PRECAUTIONS

Since the use of high voltages which are dangerous to human life is necessary to the successful operation of the radio transmitting equipment covered by these instructions, certain reasonable precautionary measures must be carefully observed by the operating personnel during the adjustment and operation of the equipment.

It should be borne in mind that interlocks are provided only on normal access doors on certain major units. Therefore side, back or top screens, commutator covers, if removed, will not cause interlocks to function and will thereby allow access to circuits carrying voltages dangerous to human life.

The major portions of the equipment are within shielding enclosures, provided where necessary with access doors which are generally fitted with safety interlock switches which act to shut off dangerous voltages within the enclosures when the access doors are open.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed.

KEEP AWAY FROM LIVE CIRCUITS. Under no circumstances should any person be permitted to reach within, or in any manner gain access to, the enclosure with interlocked gates or doors closed or with power supply line switches to the equipment closed; or to approach or handle any portion of the equipment which is supplied with power, or to connect any apparatus external to the enclosure to circuits within the equipment; or to apply voltages to the equipment for testing purposes while any non-interlocked portion of the shielding or enclosure is removed or open. Wherever feasible in testing circuits, check for continuity and resistance rather than directly checking voltage at various points.

DON'T SERVICE OR ADJUST ALONE. Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS. Under no circumstances should any access gate, door or safety interlock switch be removed, short-circuited, or tampered with in any way, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO THE BUREAU OF SHIPS MANUAL OF ENGINEERING INSTRUCTIONS, CHAPTER 31 (MIMEOGRAPHED FORM OR SUBSEQUENT REVISIONS THEREOF) ON THE SUBJECT OF "RADIO-SAFETY PRECAUTIONS TO BE OBSERVED."

REPORT OF FAILURE

Report of failure of any part of this equipment, during its service life, shall be made to the Bureau of Ships in accordance with current instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For report of failures during the specified guarantee period, see Bureau of Engineering Circular Letter No. 40b, dated January 16, 1939, or subsequent revisions thereof.

In order to expedite the handling of requisitions in the Bureau of Ships, the requisitions for replacement material should include complete descriptive data covering the part desired, in the following form:

Name of part, ratings; type number with prefix and suffix designation, if practicable; the complete model designation of the equipment, including suffix or prefix designation in which the part is used; symbol number of the part; and page number of the instruction book in which part is described.

PERTINENT DATES

The blank spaces indicated below should be filled in immediately upon completion of the initial service installation. The date of acceptance by the Navy can be determined by the stamped acceptance plate located on the panel of the equipment.

CONTRACT...DATE OF CONTRACT..........................

SERIAL NUMBER OF EQUIPMENT.... ....

DATE OF ACCEPTANCE BY THE NAVY..

DATE OF DELIVERY TO CONTRACT DESTINATION..

DATE OF COMPLETION OF INSTALLATION...

DATE PLACED IN SERVICE...

DATE OF EXPIRATION CONTRACTUAL GUARANTEE..

GUARANTEE

The equipment including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten per cent (10%) or more of any such said item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred per cent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for affecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any such defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

HOW TO USE THIS BOOK

The reader will save himself much time in mastering the operation of the equipment if he learns the plan of this book at the outset and then studies the text and illustrations in the manner suggested.

The first four sections of the book — Description, Installation, Operation, and Maintenance — contain the essential information which every operator and technician should master. (The sections covering Installation and Maintenance are not required by operators.) Sections 5 and following are devoted to detailed circuit analyses of individual units. These are written for experienced radio technicians who may be called upon to make extensive repairs and modifications. They are also useful for instruction purposes in Radar schools.

Schematics covering all units of the equipment will be printed with the detailed circuit analyses and in the back of the book. These should be frequently referred to when studying the text, as they are essential to a real understanding of operation. Complete lists of parts and spare parts are included. These are useful not only for servicing and replacing equipment but also for learning the electrical values and function of components not elsewhere described.

To make use of schematics and parts lists, it is essential to understand the system of component symbols and cabling designations as explained in Sections 1.2 and 1.3. The Table of Contents and List of Illustrations in the front of the book show the location of all text and illustrations (including schematics) and explain the numbering system employed.

Section 1—Description

INTRODUCTION

Navy Model SO-1 Radar is a medium-power surface-scanning equipment designed for installation on light craft having a 115-volt d.c. power supply.

Targets on or near the surface of the water are shown in a map-like presentation (in polar co-ordinates) on the screen of the Plan Position Indicator (PPI). The bearing of a target in relation to the axis of the craft (relative bearing) is determined by aligning the rotatable bearing cursor (vane) with the center of the target trace and reading the bearing on the dial surrounding the tube. Target range is determined in two ways: approximate range is estimated from calibrated range markers, and accurate range is read from a dial on the Accessory Control Unit when used.

A marine-type Motor-Alternator is used to convert the 115-volt d.c. ship's power to 400-cycle power at the same voltage. The 400-cycle power operates the Modulator, Transmitter, Receiver, Plan Position Indicator, Rectifier Power Unit, and the synchro motors. It also operates the optional Accessory Control Unit. The antenna drive motor is operated directly from the 115-volt d.c. ship's source.

A synchronized rotary spark gap is used to key the Transmitter by discharging the d.c.-charged pulse line in the Modulator. With such a system the adjustment of gap timing (phasing) is relatively non-critical, thus simplifying maintenance and making the system substantially independent of changes in motor speed.

Operation of the equipment has been simplified as far as possible without sacrificing performance.

1.0 FUNCTIONAL OPERATION

General

Refer to the pictorial block diagrams (Figs. 1A and 1B). In Fig. 1A (Transmission), the white lines show the square-wave pulse from the Modulator going to the Transmitter, and r.f. energy from the Transmitter passing up the waveguide to the Antenna and radiating towards the target. It also shows a low-amplitude "sample" of the pulse going from the Modulator to the Indicator to synchronize the PPI sweep and other circuits. In Fig. 1B (Reception), the white lines show r.f. energy returning from the target to the Antenna, passing down the waveguide to the Receiver, and going to the Indicator in the form of video signals. The signal is visible on the PPI screen as a bright spot on the radial sweep (slightly to the right of center), showing the range and bearing of the target.

Also refer to the block diagram, "Basic Functional Operation" (Fig. 2). In this diagram, *heavy* broken lines show the outgoing energy, and *light* broken lines show the echoes returning from the target.

Power Source

A 3-h.p. compound motor operated from the ship's 115-volt d.c. power drives the Alternator which generates 400-cycle power at 115 volts. This potential is stepped up by a transformer to approximately 9.5 kv., half-wave rectified, and delivered to the pulse line.

Oscillator Keying

The pulse line (when properly terminated) has the characteristic of discharging completely and with a practically uniform current of approximately 85 amperes in a period of one microsecond. Discharge is effected through the primary of the pulse transformer by a spark gap switch mechanically coupled to the Alternator and synchronized to the 400-cycle frequency. Thus the 400-cycle alternator output is finally converted into a one-microsecond square-wave voltage across the primary of the pulse transformer, recurring 400 times a second (i.e., at intervals of 2500 microseconds).

A low-amplitude sample of this pulse is delivered to the Indicator to trigger (synchronize with the transmitted pulse) the radial sweep, the range marks oscillator, the PPI unblanking circuit, and the Accessory Control Unit.

The pulse transformer, located in the Transmitter-Receiver Unit, is so designed that it passes the main pulse and increases its amplitude to approximately 18 kv.

These one-microsecond pulses are applied to the magnetron oscillator at a peak power input of approximately 250 kw. and a repetition rate of 400 c.p.s. Once each repetition cycle, power is applied and microwave energy is generated by the oscillator and radiated directly into a pre-tuned r.f. system.

R.F. Radiation

The r.f. output is conducted to the Antenna through a hollow waveguide (transmission line) and radiated onto the surface of a reflector. The reflector, which has the form of a paraboloidal section, concentrates and re-radiates the energy in a narrow beam. The radiated pattern is about 5° in the horizontal and 15° in the vertical plane. As the Antenna rotates, the beam sweeps over the surrounding surface area.

Reception of Echoes

When the transmitted signal strikes a target, a small part of the energy is reflected back to the Antenna. The reflector returns a part of this energy to the waveguide and Receiver via the TR box (duplexing cavity) located in the Transmitter-Receiver Unit. The TR box acts as an automatic electronic switch, connecting the Receiver to the waveguide while the Transmitter is off and isolating the Receiver from the waveguide while the Transmitter is on.

The signal is amplified and detected in the Receiver, which is of the superheterodyne type, and delivered through a coaxial line to the Indicator as a rectified video signal. Here the video signal is again amplified and applied to the control grid of the PPI tube, finally appearing on the tube screen as a small bright arc or spot (see Fig. 8).

Synchronization of PPI Sweep

The radial sweep of the PPI tube starts with the transmitted pulse and reaches the edge of the PPI screen in the exact time required for the r.f. energy to travel to and return from a target situated at the distant limit of the selected range. Suppose, for example, that while operating on the 20-mile range, a target 20 miles distant is being observed on the PPI screen. The r.f. energy would then have to travel 40 miles — 20 miles out and 20 miles back. Since radio waves travel one Radar mile (2000 yards) in 6.12 microseconds, the PPI sweep would move from the center to the edge of the screen in $6.12 \times 40 =$ approximately 245 microseconds.

Determination of Range

Because of this synchronism between signal and sweep, the distance of the target trace from the center of the screen is directly proportional to the distance of the target from the Antenna. Target range can therefore be determined by noting the position of the target trace with reference to the calibrated range marks (see Fig. 8A). More accurate ranging information may be obtained from the Accessory Control Unit by rotating the range crank until the "accurate range mark" on the PPI tube coincides with the echo to be ranged, and reading the range directly from a dial mechanically coupled to the range crank (see Fig. 7).

Determination of Bearing

While the radial sweep is moving outward from the center of the tube in synchronism with the transmitted signal, the trace is made

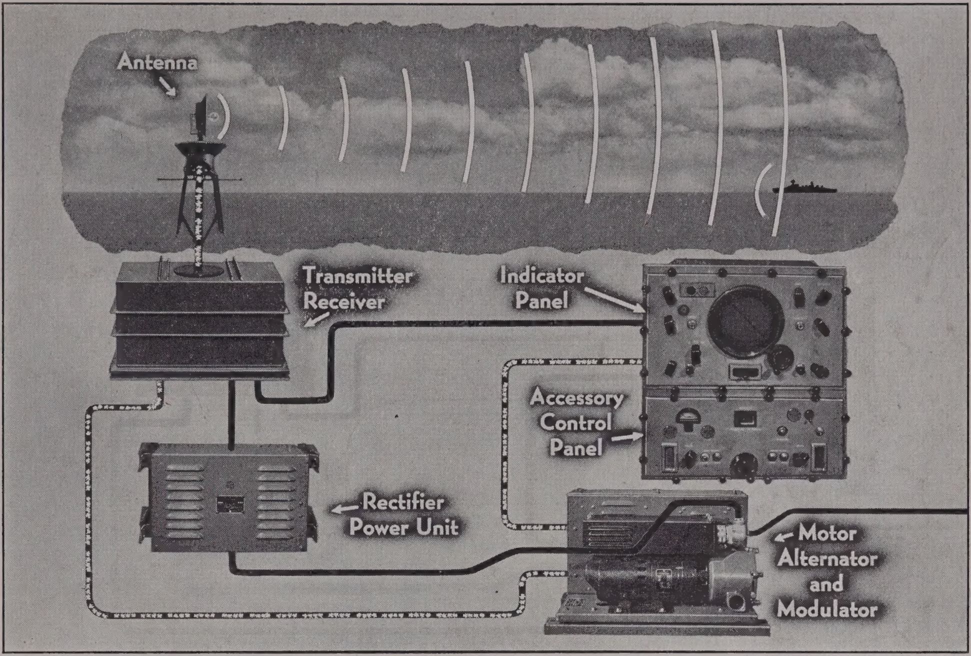

Antenna
Transmitter Receiver
Indicator Panel
Accessory Control Panel
Rectifier Power Unit
Motor Alternator and Modulator

FIG. 1A — TRANSMISSION OF R.F. ENERGY.
(DIAGRAM SHOWS UNITS OF ORIGINAL MODEL SO EQUIPMENT, BUT ALSO ILLUSTRATES FUNCTIONAL OPERATION OF SO-1 EQUIPMENT.)

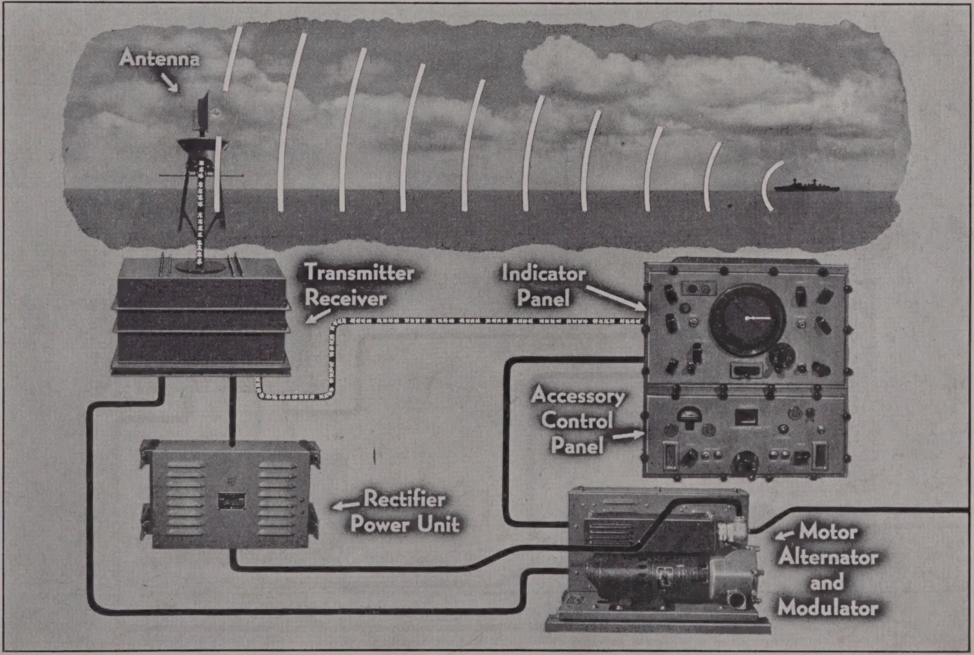

Antenna
Transmitter Receiver
Indicator Panel
Accessory Control Panel
Rectifier Power Unit
Motor Alternator and Modulator

FIG. 1B — RECEPTION OF ECHOES FROM TARGET.

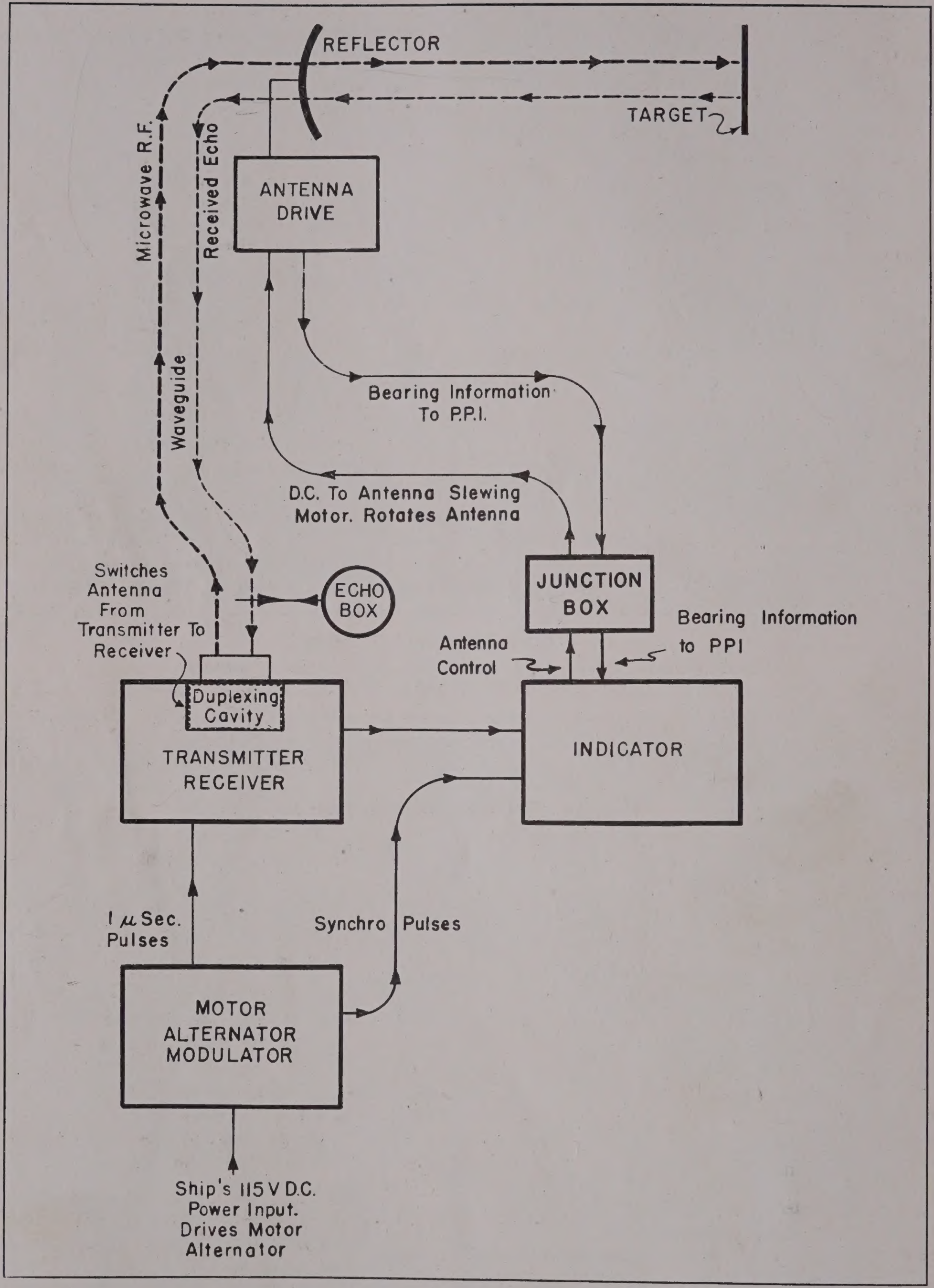

REFLECTOR
TARGET
Microwave R.F.
Received Echo
Waveguide
ANTENNA DRIVE
Bearing Information To P.P.I.
D.C. To Antenna Slewing Motor. Rotates Antenna
Switches Antenna From Transmitter To Receiver
ECHO BOX
JUNCTION BOX
Bearing Information to PPI
Antenna Control
Duplexing Cavity
TRANSMITTER RECEIVER
INDICATOR
1 μ Sec. Pulses
Synchro Pulses
MOTOR ALTERNATOR MODULATOR
Ship's 115 V D.C. Power Input. Drives Motor Alternator

FIG. 2—BASIC FUNCTIONAL OPERATION.

to rotate around the center of the tube in unison with the rotation of the Antenna on the mast. Thus the angular position of the sweep always corresponds with the angular position of the Antenna. (In equipments converted for true-bearing indications, the sweep position corresponds to the true-bearing angular position of the Antenna.)

Operation of Synchro System

This synchronization between the rotating Antenna and the rotating PPI sweep is accomplished by means of the synchro system. A synchro generator, geared to the Antenna, electrically controls the rotation of the deflection coil producing the sweep.

Rotation of the Antenna is initiated by a 115-volt d.c. antenna drive motor energized directly from the ship's supply. The synchro generator is coupled through a 1-to-10 speed-increasing gear train to the antenna spindle. This synchro generator delivers bearing information to the synchro motor which turns the radial sweep coil of the PPI tube through a 10-to-1 speed-reducing gear train. Thus the desired synchronism is obtained.

At the time of installation the Antenna is zeroed; i.e., adjusted so that the PPI sweep indicates 0° when the Antenna is pointing dead ahead. All bearing indications are therefore relative to the ship's heading.

NOTE: A mechanical differential is already installed in the Antenna, and auxiliary equipment (Bearing Control Unit) will be provided in the field so that the present relative-bearing system may later be converted for true bearing.

Range of Equipment

The range of the equipment depends primarily upon the location, size and character of the target, and to a lesser degree upon existing weather conditions. Under average conditions this set is capable of locating targets of fair size as far as the optical horizon; under unusually favorable conditions targets have been detected at the maximum range of the Indicator.

Tuning by Resonance Chamber

In the absence of actual targets, the Receiver is tuned by the use of the Resonance Chamber (Echo Box) (see Fig. 11). This unit provides a high-Q tuned circuit in which oscillations persist for some time after the transmitted pulse stops. These oscillations are returned as damped waves via the waveguide to the Receiver, thus simulating echoes received from an actual target.

* * *

This subsection should now be restudied with the aid of the more detailed block diagram (Fig. 3).

1.1 LIST OF INCLUDED UNITS

Model SO-1 Radar Equipment consists of the following separate units:

The Antenna Assembly comprises: (a) a drive mechanism including a drive motor and gear train; (b) a synchro system including a synchro generator, gear train, and mechanical differential (for use in true-bearing systems); (c) a rotating radiating system including a right-angle radiating nozzle, a reflector in the form of a paraboloidal section, r.f. fittings for coupling the rotating radiating system to the stationary waveguide; and (d) a supporting pedestal and base plate.

The Motor-Alternator-Modulator comprises a 115-volt d.c. drive motor, a 115-volt 400-cycle Alternator, a spark gap for keying purposes, and a Modulator. The Modulator includes a charging transformer and rectifier, and a pulse line; it also contains an electronic voltage regulator for the Alternator. A Magnetic Controller and a start-stop push button switch (both separately mounted) are provided for starting the motor.

The Transmitter-Receiver, as the name indicates, combines two units in a single case for transmitting and receiving r.f. energy. The Transmitter comprises a high-voltage pulse transformer, a magnetron oscillator, an r.f. system, and a TR box (duplexing cavity). The Receiver is a compact superheterodyne type. A blower motor is included for cooling.

The Plan Position Indicator mounts the chief operating controls, except the Main Line Switch and echo box control. It also houses a PPI tube with its deflection coil drive and bearing dial, and its video and sweep circuits.

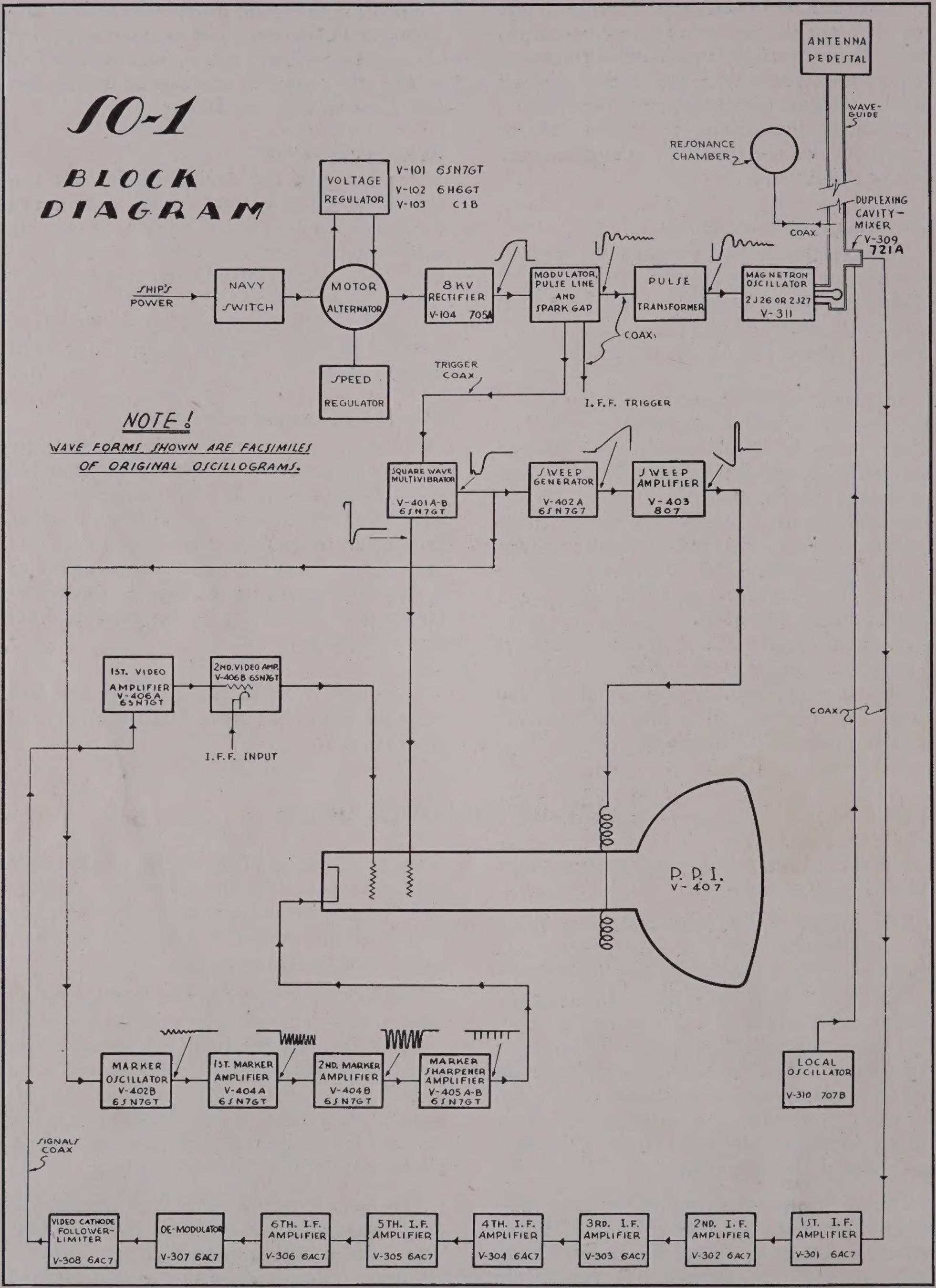

SO-1
BLOCK DIAGRAM
ANTENNA PEDESTAL
WAVE-GUIDE
RESONANCE CHAMBER
DUPLEXING CAVITY-MIXER
V-309 721A
COAX
VOLTAGE REGULATOR
V-101 6SN7GT
V-102 6H6GT
V-103 C1B
SHIP'S POWER
NAVY SWITCH
MOTOR ALTERNATOR
SPEED REGULATOR
8 KV RECTIFIER V-104 705A
MODULATOR, PULSE LINE AND SPARK GAP
PULSE TRANSFORMER
MAGNETRON OSCILLATOR 2J26 OR 2J27 V-311
COAX
TRIGGER COAX
I.F.F. TRIGGER
NOTE!
WAVE FORMS SHOWN ARE FACSIMILES OF ORIGINAL OSCILLOGRAMS.
SQUARE WAVE MULTIVIBRATOR V-401A-B 6SN7GT
SWEEP GENERATOR V-402 A 6SN7GT
SWEEP AMPLIFIER V-403 807
1ST. VIDEO AMPLIFIER V-406A 6SN7GT
2ND. VIDEO AMP. V-406B 6SN7GT
I.F.F. INPUT
COAX
P. P. I. V-407
MARKER OSCILLATOR V-402B 6SN7GT
1ST. MARKER AMPLIFIER V-404A 6SN7GT
2ND. MARKER AMPLIFIER V-404B 6SN7GT
MARKER SHARPENER AMPLIFIER V-405 A-B 6SN7GT
LOCAL OSCILLATOR V-310 707B
SIGNALS COAX
VIDEO CATHODE FOLLOWER-LIMITER V-308 6AC7
DE-MODULATOR V-307 6AC7
6TH. I.F. AMPLIFIER V-306 6AC7
5TH. I.F. AMPLIFIER V-305 6AC7
4TH. I.F. AMPLIFIER V-304 6AC7
3RD. I.F. AMPLIFIER V-303 6AC7
2ND. I.F. AMPLIFIER V-302 6AC7
1ST. I.F. AMPLIFIER V-301 6AC7

Fig. 3 — Block Diagram.

The Accessory Control Unit (A.C.U.) (optional) provides means for superimposing a movable marker spot on the PPI tube for determining accurate range (see Fig. 7). Range is directly indicated on a dial coupled to a hand-crank controlling the location of the spot. Also provided are an a.c. line voltmeter, a toggle switch for controlling the ship heading flasher circuit when a true-bearing system is installed, and a key switch and gain control for operating IFF equipment when used.

The Resonance Chamber (Echo Box) provides a high-Q tuned circuit producing an artificial echo on the PPI tube for tuning the Receiver in the absence of actual targets.

The Rectifier Power Unit contains a power supply for the Receiver, a relay controlling high voltage to the Modulator, and fuses. Its case also serves as a junction box for cables.

The IFF Control Unit contains a key switch and gain control for operating external IFF equipment. It also provides an a.c. line voltmeter for the Radar equipment (see Fig. 10). This unit is installed to provide a line voltmeter, even in the absence of IFF equipment; but since both functions of the unit are performed by the A.C.U., the IFF Control Unit is employed only when the A.C.U. is not installed.

The Bearing Control Unit (optional – true-bearing systems only) contains a step-by-step to Autosyn converter, a Bendix servo amplifier, and a true–relative switch.

The Junction Box provides terminal strips for connecting the cables running between the Antenna and other units. The box also contains relays for controlling the rotation of the Antenna.

1.2 LOCATION OF COMPONENTS

For a clear understanding of the operation of the SO-1 Radar, constant reference should be made to the photographs and schematics while reading the text.

Although the equipment comprises a number of separate units, no trouble should be experienced in tracing circuits if the following classification of components is understood.

Each unit has been assigned its own identifying number series, and each component in a unit bears a number within the series. For example, the Transmitter-Receiver Unit has been assigned the 300 series, and thus any component bearing a number between 301 and 399 is identified as part of the Transmitter-Receiver Unit. Each number is stenciled, stamped, or engraved near its component.

Unit	*Number Series*
Motor-Alternator-Modulator	101–199
Rectifier Power Unit	201–299
Transmitter-Receiver	301–399
Plan Position Indicator	401–499
Antenna Assembly	501–599
Resonance Chamber	601–699
Accessory Control Unit	701–799
Voltage Regulator	1101–1199
IFF Control Unit	1201–1299
Junction Box	1301–1399
Bearing Control Unit	1401–1499

Preceding every component number is a letter which shows the functional classification of that component. Letters have been assigned as follows:

B	Motors and synchros
C	Capacitors
E	Terminal strips, solenoids, etc.
F	Fuses
I	Indicators (pilot and dial lamps)
J	Jacks (receptacles)
K	Contactors (relays)
L	Inductors
M	Meters
P	Plugs and probes
R	Resistors
S	Switches, interlocks, and thermostats
T	Transformers
V	Vacuum and gaseous tubes
W	Cables (special)
X	Sockets and fuse blocks
Y	Crystals
Z	Complete r.f. assemblies
CR	Copper oxide rectifiers
RF	R.F. assemblies
SR	Selenium rectifiers
TC	Tuned circuit
VR	Voltage regulators

Each component in a unit is designated by a symbol composed of a letter (identifying its function) plus a number falling within a number series (identifying the unit containing it). Thus, B-301 is a motor in the Transmitter-Receiver Unit (the blower motor), and S-402 is a switch in the Indicator Unit (the Antenna Switch).

1.3 CABLING DESIGNATIONS

The terminal numbers of all interconnecting cables are the same at both ends. For example, referring to cabling schematic W-4-W4, Cable X (MHFA-14) connects terminal strip E-113 in the Motor-Alternator-Modulator to terminal strip E-201 in the Rectifier Power Unit. The individual conductors connect to correspondingly numbered terminals at each end.

A given number always refers to the same circuit, even when it reappears in a different unit.

The convenience of these corresponding terminal numbers, both for tracing circuits and installing connecting cables, can readily be appreciated by reference to the unit schematics. Connections carried over by cables from one unit to another are so indicated on the schematics. For example, on the schematic for the Motor-Alternator-Modulator Unit, terminals 1, 2, 3, 4, 5, 36, and 46 on E-113 are bracketed, and reference is made that these connections are carried over to the Rectifier Power Unit.

1.4 PHYSICAL CHARACTERISTICS

Unit	*Weight (Lbs.)*	*Actual Mounting Clearance (Inches)*
Antenna Assembly CRP-66AFL	267	Diameter — 48 Height — 43
CRP-66AGE	279	Diameter — 55 Height — 29½
Resonance Chamber CRP-14AAN	3½	Diameter — 7 Height — 9 Length — 12¾
Transmitter-Receiver Assembly CRP-43ABY	93	Width — 23½ Height — 18½ Depth — 16
Receiver CRP-46ACA-1	6½	
Plan Position Indicator CRP-55ADQ	93	Width — 19¼ Height — 13⅓ Depth — 24¼
Rectifier Power Unit CRP-20225	30	Width — 21½ Height — 11½ Depth — 10½

1.4 PHYSICAL CHARACTERISTICS (Cont.)

Unit	*Weight (Lbs.)*	*Actual Mounting Clearance (Inches)*
Motor-Alternator-Modulator		
CRP-21ACD		
With CRP-10212 Gap	474	Width — 50
With CRP-10249 Gap	465	Height — 20½
		Depth — 19½
Motor-Alternator and Mounting Base CLL-211043	365	
Modulator CRP-20ACX	85	
Spark Gap		
CRP-10212 (Early Type)	25	
CRP-10249 (Late Type)	19	
Start-Stop Push Button	3½	Width — 3
CBZ-24216		Height — 5½
CABS-24241 (random equipments)		Depth — 3
Magnetic Controller		
CDD-211045	53½	Width — 14
		Height — 12½
		Depth — 13½
IFF Control Unit and Line Voltmeter	7	Width — 9¼
CRP-23ADD		Height — 8¼
		Depth — 8¾
Accessory Control Unit	63	Width — 19⅓
CRP-23ADZ		Height — 9½
		Depth — 23½
Indicator and Accessory Control Unit	171	Width — 19¼
Mounted in Cradle		Height — 21½
		Depth — 24¼
Junction Box		
CRP-62108	45	Width — 16
		Height — 20
		Depth — 10
Bearing Control Unit	43	Width — 21½
CRP-23AEK		Height — 9⅝
		Depth — 10¾

NOTE: Refer to "List of Illustrations" in the front of this book for location of photographs showing the various units.

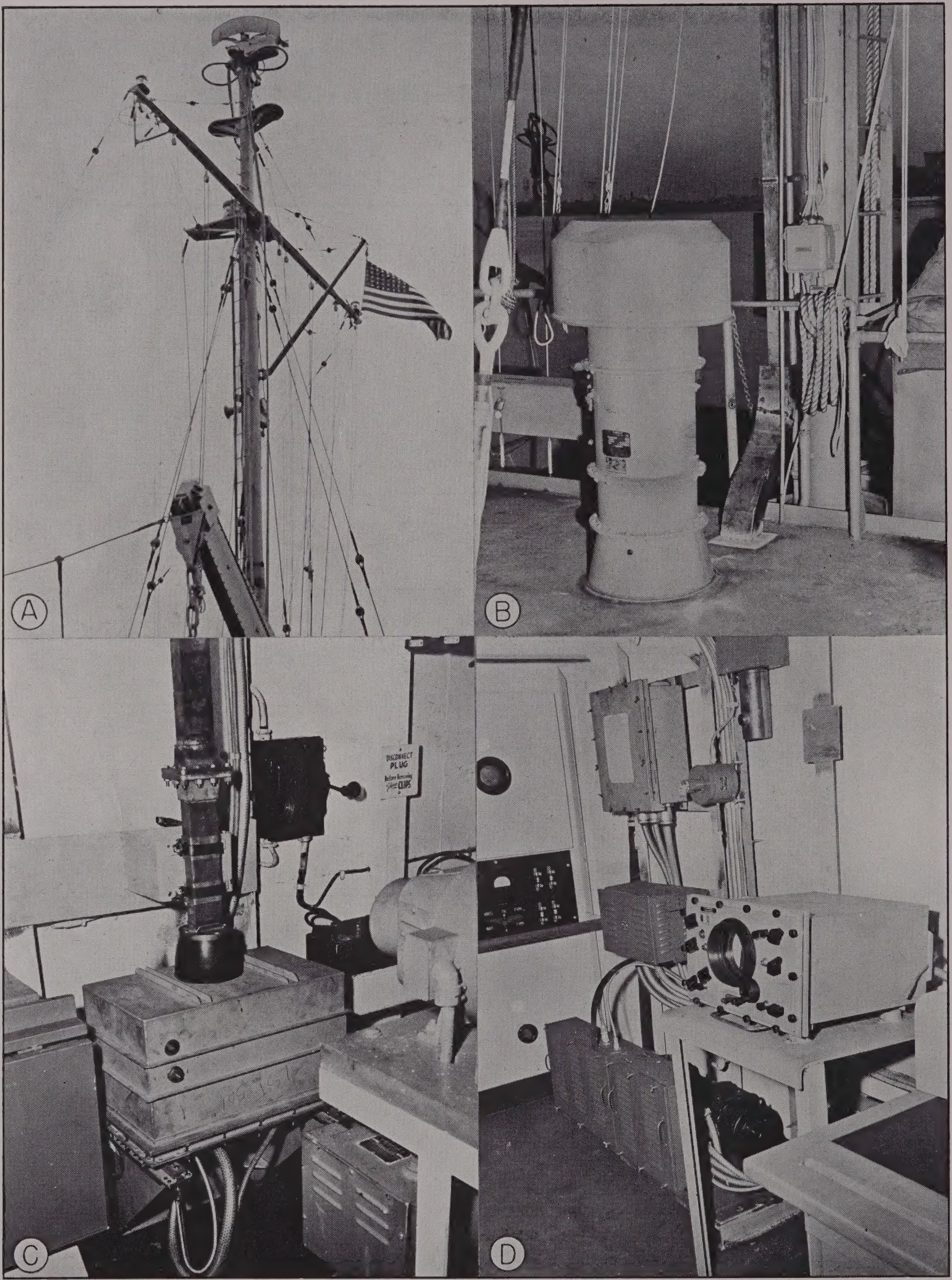

A
B
DISCONNECT
PLUG
Before Removing
CLIPS
C
D

Fig. 4—Typical SO-1 Installation on LST craft. (A) Antenna Assembly; (B) waveguide run showing deck kick pipe; (C) Transmitter-Receiver and Magnetic Controller; (D) Motor-Alternator-Modulator, Rectifier Power Unit, Junction Box, Plan Position Indicator, and Echo Box.

Section 2 — Installation

2.1 POWER REQUIREMENTS

Model SO-1 Radar is designed to operate from a 115-volt d.c. source, and under normal operating conditions draws approximately 3 kw. The alternator field circuit is automatically regulated, and the 400-cycle alternator output remains at 115 volts ±5 volts. Frequency regulation is provided.

2.2 INSTALLATION LAYOUT

Standard layouts for the installation of Model SO-1 Radar on specified craft have been prepared by the Planning Departments of several Navy Yards. These plans are available at most installation bases, or may be obtained by writing to the Bureau of Ships. Consequently, no layouts are included with this text.

The Antenna Assembly, Transmitter-Receiver, and Junction Box are watertight and may be mounted in exposed locations. The remaining units should be sheltered from the weather.

2.3 HOUSINGS AND SUPPORTS

Housings and supports will be shown on the Navy Yard plans. Where plans are not available the following factors must be carefully considered before locating the unit:

(a) Accessibility for adjustments and maintenance.
(b) Operating convenience.
(c) Ventilation.
(d) Protection from weather.
(e) Inter-unit cabling.
(f) Interference with other equipment (see page 15).
(g) Short and direct runs for waveguide and coaxial cables.

2.4 INSTALLATION REQUIREMENTS

The locations of units cannot be completely standardized as they vary with different types of craft. This applies especially to the Motor-Alternator-Modulator.

The Antenna Assembly bolts to a plate fitted to the mast. A platform should be provided on the mast below the Antenna for servicing.

The waveguide should be clamped to the mast every few feet with lead-lined cleats. (Detailed procedures for fabricating and brazing waveguide are given in the special report entitled "Instructions for the Installation of 1½ × 3″ Waveguide Pipe and Fittings for Use with Radar," published by the Brooklyn Navy Yard.)

Cable entrances to the Antenna should be made by means of standard terminal tubes. When these tubes are installed, the threads should be coated to prevent freezing-in, since they will have to be removed if it becomes necessary to replace the Antenna. Ordinary cup grease or anti-seize compound is suitable for this purpose. All terminal tubes must be made watertight.

All tubes and cables as well as the outside of the waveguide should be carefully chromated and painted after installation to prevent corrosion.

THE MOTOR-ALTERNATOR-MODULATOR is located in different places, depending on the type of craft. Provision should be made for accessibility, as frequent inspection will be required. If the unit is mounted against a bulkhead, it must be so positioned that the modulator covers are away from the bulkhead and the Modulator can be easily reached. The spark gap assembly must be accessible as it, too, will require frequent inspection. Brushes in the Alternator, exciter, and spark gap will require replacement, and space must be allowed for this work. At least 18″ of access space should be provided on all sides of the Motor-Alternator-Modulator.

If a shelf is used, it should be 12″ to 18″ above the deck. At least 18″ of clearance space should be provided on all sides of the unit to allow for servicing; and more, if possible, should be provided at the spark gap end.

The spark gap exhaust should be made externally by means of the flexible hose provided. This hose must be so installed that the glass water trap on the spark gap is at the lowest point in the run. The hose should be as short as possible and sharp bends should be avoided. *The air vent assembly must be installed on the end of the hose to prevent water from entering the gap.* Locate the vent in a sheltered spot. Numerous cases have been found where the vent shipped enough water to overflow the water trap and back up into the spark gap.

THE TRANSMITTER-RECEIVER usually mounts at the base of the antenna mast and connects to the Antenna through a length of waveguide, which is shipped in standard lengths. The unit is preferably mounted in a sheltered location where it can be serviced during bad weather. After the unit has been placed on its mounting rails and slid to its proper location, the lower waveguide flange must be aligned with the waveguide coupler on top of the unit. The waveguide run and Transmitter placement must be carefully planned to insure this alignment.

Cable entrance to the Transmitter should be made through watertight terminal tubes. Sufficient slack should be left in the cables to provide for occasional repair of the cable ends, and to permit removal of the Transmitter for servicing. All cables should be protected so that they will not be used as grab rails. Where cables pass through the deck they should be protected by watertight kick pipes.

THE MAIN LINE SWITCH is not provided with the equipment and will be supplied by the Navy. The switch supplied should be checked to make sure that it is at least of 60-amp. capacity. It should preferably be flameproof, but a non-flameproof switch may be used if a warning is posted not to remove the switch cover without first cutting off the power at the distribution panel in the engine room. Both the Main Line Switch and the switch on the distribution panel should be properly labeled.

If the switch on the distribution panel is of the circuit-breaker type, it must be capable of withstanding a normal starting surge of over 100 amps.

The main power supply should always be fused with 60-amp. single-link fuses. (During starting these fuses may carry over 100 amps. for one or two seconds.)

THE PLAN POSITION INDICATOR is shock mounted on a shelf or table, usually in the chart house. It should be readily accessible, and clearance must be allowed for removal of the unit from its case. Sufficient slack should be left in the connecting cables so that the unit can be moved to give access to the terminal box at the rear. When the Indicator is mounted below the operator's eye level, the front of the unit should be raised about 2″ to improve visibility. Watertight terminal tubes must be used, since the unit uses dehydrator plugs.

THE ACCESSORY CONTROL UNIT (optional) is mounted above the Indicator in a special cradle which holds both units. Since the cradle is provided with shock mounts, shock mounts on the Indicator are removed and the two units are bolted directly to the frame. Watertight terminal tubes must be used, since the unit uses dehydrator plugs.

THE IFF CONTROL UNIT AND LINE VOLTMETER is mounted within easy reach of the Plan Position Indicator and preferably to the right of it. This unit is not used if an Accessory Control Unit is installed.

THE RESONANCE CHAMBER (ECHO BOX) should be mounted on a bulkhead near enough to the Indicator to be conveniently observed by the operator (see Fig. 10D). It should not be exposed to mechanical damage. The coax cable connecting the unit to the waveguide should be made as short as possible while allowing some slack for repairs. The armored cable should be painted after installation to prevent corrosion.

THE RECTIFIER POWER UNIT may be located wherever convenient, consistent with good ventilation and accessibility.

THE JUNCTION BOX is waterproof and uses dehydrator plugs. It may be mounted wherever convenient, either inside or out.

2.5 CABLING AND CONNECTIONS

GENERAL INSTRUCTIONS

Refer to the external cabling diagram and carefully follow all specifications as to cable type.

Use standard Navy armored cable for all inter-unit connections, except the pulse cable (No. VI). Run all cables in accordance with standard marine wiring practice. Allow an extra foot or two at terminations to permit the removal of units for servicing and the repair of the cables themselves.

Lug and number all individual conductors. *When crimped-type lugs are used they should be soldered as well as crimped.*

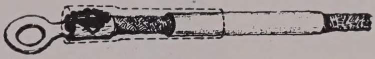


FIG. 5 — LUG PROTECTED BY SPAGHETTI.

Take care to prevent short circuits at terminal strips and jack and plug assemblies. Remove insulation from conductors only far enough to make good soldered connections, and avoid dropping solder and wire clippings between terminals. Place a short piece of spaghetti tubing or insulating tape over the junction of each conductor where it enters the shank of the soldering lug (see Fig. 5). This will prevent frayed insulation, broken leads, and shorts between adjacent lugs. Check all banana jacks and plugs for tightness before attaching the lug leads; otherwise loose fittings may turn and short adjacent leads. Lace tightly into cables all leads terminating on terminal strips or on jack or plug assemblies.

Bond all external shielding (armor) at several points to the ship's common grounding strip to prevent or lessen interference between the Radar and other equipment. This bonding will also prevent static charges on the units and arcing to ground.

SPECIFIC INSTRUCTIONS

Use standard Navy cable clamps at entrances where protection from moisture is not required. However, use terminal tubes at all cable entrances to the Antenna, Transmitter-Receiver, Indicator, A.C.U., and Junction Box, since these units are moisture-proof when shipped, and must be kept so to prevent corrosion. Terminal tubes on the Indicator should preferably be the right-angle type. It is standard Navy practice to use stuffing tubes where cables pass through decks and bulkheads, but usage varies somewhat with different yards.

Run all cables to the Transmitter-Receiver on the same side to permit removal of the Transmitter-Receiver from its mount. Lash together the cables running between the unit and the deck to prevent strain on coaxial lines in case they are used for grab rails in a rough sea. Use Cable VII, which is heavy, as a support for the coax cables, securing the bundle with a serving of marline.

COAXIAL CABLES

All coaxial cables are fragile and must be handled with care. Do not bend them on less than a 5″ radius. Keep them away from hot objects, such as engine exhaust pipes. Procedures for making up coaxial fittings are given at the end of Sec. 4.

The pulse cable (No. VI) is the only cable supplied by Raytheon. It will be a complete armored cable, either an RG-14/U or an RMA-10. It must be made up properly as shown at the end of Sec. 4. (The old-type B-48 pulse cable may be encountered in yard spares.

This cable has no outer shielding and requires the addition of regular Beldon braid or similar shielding pulled over it.)

Cable II between the waveguide and the Resonance Chamber must be kept as short as possible.

2.6 TUBING OF EQUIPMENT

The equipment is shipped from the factory with a full complement of tubes mounted in their proper sockets. Spare tubes, marked as to type, are included in equipment spares. All tubes are equipped with locking devices to keep them from working loose under vibration or shock. Nevertheless, before any attempt is made to operate the equipment for the first time, all tubes should be checked to make sure that they are firmly seated in their sockets.

Most of the tubes are secured by spring grips which may be unlocked by depressing the springs. Some of the metal tubes in the Receiver are secured by shields which may be removed by unscrewing, and the remainder are held by a cover strip which is fastened to the receiver chassis with two round-head machine screws.

CAUTION: The magnetron, McNally oscillator, and cathode-ray tubes are secured by special devices. Since these tubes are fragile, no attempt should be made to replace them until the special instructions given under Maintenance and Service have been carefully read.

2.7 CHECK-UP FOLLOWING INSTALLATION

(a) Make sure that a drainage hole has been provided in the rubber waveguide boot. If not, see Navy Modification #26 in the Radar Maintenance Bulletins.

(b) Check all wiring by color code or with a continuity meter. Make sure that all connections are properly made and are tight. Make sure that all cable terminal tubes are properly made up and are watertight. Check all cabling for proper clamping. Make sure that all exposed metal parts are thoroughly chromated and painted to prevent corrosion.

(c) Make sure that the tubes in all units are firmly seated in their sockets and that all fuses and ferrule resistors are properly installed in their clips.

(d) Check the condition of dehydrator plugs and replace if necessary.

(e) Check the deflection coil drive gears in the Indicator and thoroughly clean with a brush if any dirt is found.

(f) Check the polarity of the ship's supply. Check the 400-cycle output voltage to make sure that it does not exceed 120 volts. If it does exceed this value, adjust the voltage regulator (see page 50).

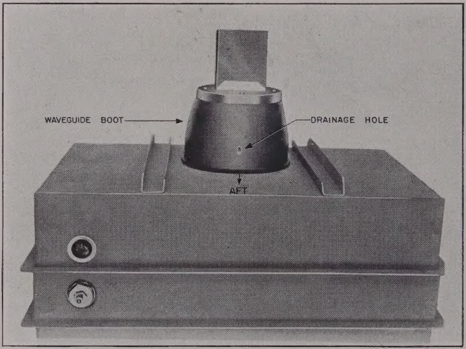


Fig. 6 — Boot Drainage Hole.

(g) Start the equipment in the normal way (see Sec. 3) and check the action of all operating controls for normal operation.

(h) Tune the local oscillator and the r.f. system (see pages 56-59). Make sure the blower motor runs properly.

(i) Align the antenna synchro (see page 62).

2.8 ELIMINATION OF INTERFERENCE

After the Radar equipment has been installed and checked, it may be found that the ship's communications equipment is picking up severe 400-cycle interference. Since the latter equipment must be continuously operative while the ship is under way, this interference must be removed.

It appears that the metal cases enclosing the Radar units are subject to standing waves which produce radiating fields. These must be balanced out. The method of accomplishing this has not yet been reduced to a definite procedure, being still a matter of trial and error.

Interference can sometimes be eliminated in SO-Series installations by bonding between all cables and parts of the ship's communication system, Radar equipment, and ground system. Interference can often be greatly reduced by bonding between the rear of the Indicator and the case of the communications equipment. The waveguide should always be bonded to the ship's ground system, but the ground lead should not be soldered directly to the waveguide tubing, because the application of heat may cause scale within the waveguide. If interference persists, it may also be necessary to bond the Motor-Alternator-Modulator, the cables, and the Transmitter-Receiver to the ship's ground system.

Other causes of interference are mentioned on page 40 under Maintenance and Service.

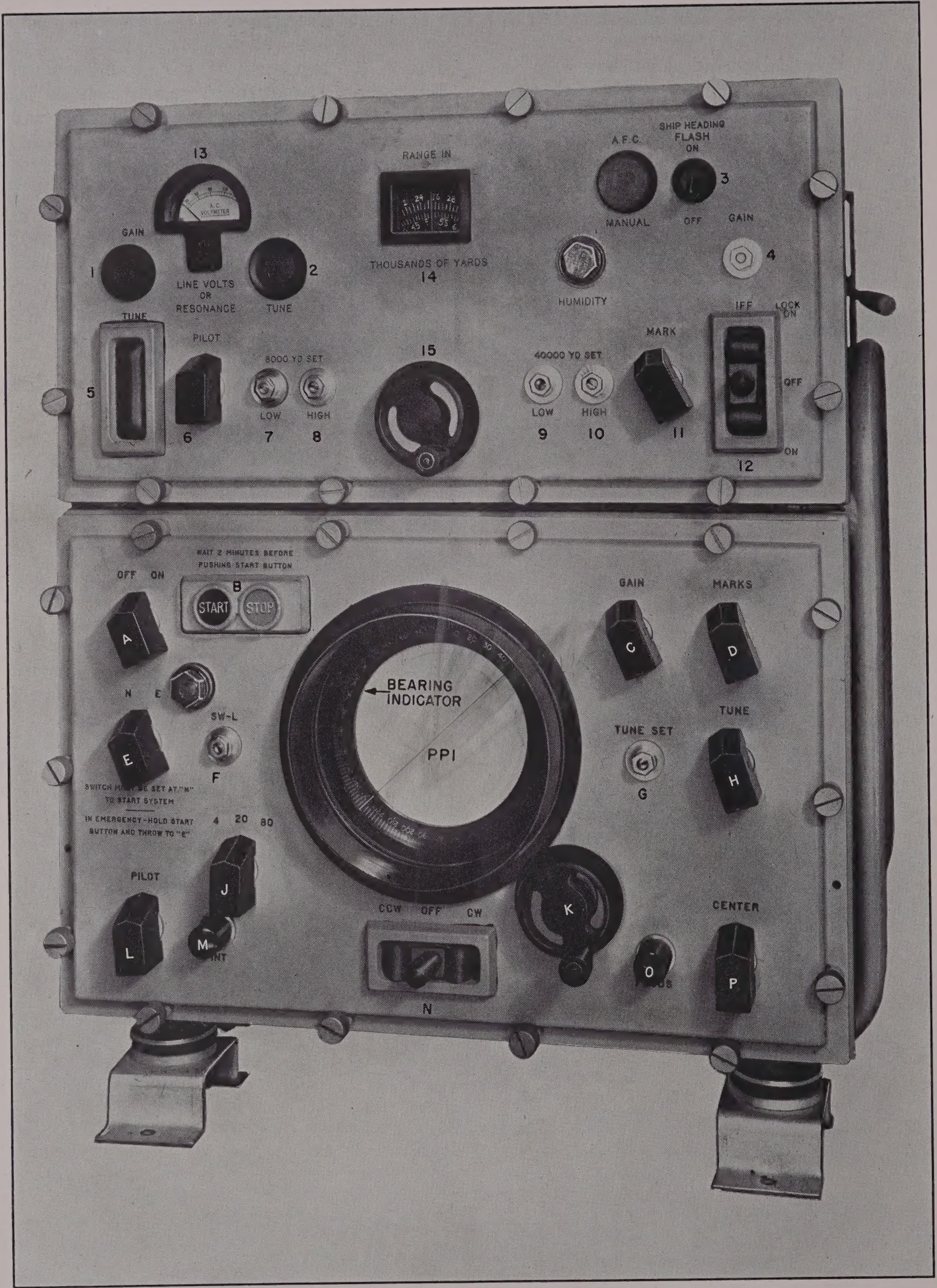

SHIP HEADING
FLASH
ON
A.F.C.
RANGE IN
13
3
MANUAL
OFF
GAIN
GAIN
4
1
LINE VOLTS
OR
RESONANCE
2
TUNE
THOUSANDS OF YARDS
14
HUMIDITY
TUNE
PILOT
IFF
LOCK
ON
MARK
8000 YD SET
15
40000 YD SET
5
OFF
LOW
HIGH
LOW
HIGH
6
7
8
9
10
11
ON
12
WAIT 2 MINUTES BEFORE
PUSHING START BUTTON
OFF
ON
B
START
STOP
GAIN
MARKS
A
C
D
BEARING
INDICATOR
N
E
SW-L
TUNE
TUNE SET
E
PPI
H
F
G
SWITCH MUST BE SET AT "N"
TO START SYSTEM
IN EMERGENCY-HOLD START
BUTTON AND THROW TO "E"
4
20
80
PILOT
J
K
CENTER
CCW
OFF
CW
L
M
INT
O
FOCUS
P
N

Fig. 7 — Accessory Control and Indicator Units: control panels.

Section 3—Operation

3.0 GENERAL

Before using the equipment, the operator should learn the locations and functions of the operating controls, most of which are located on the Indicator and on the optional IFF Control Unit or Accessory Control Unit (A.C.U.), whichever is used.[1] Controls located on the Indicator and A.C.U. are shown in the photograph (Fig. 7) with letters or numbers keyed to the text. Controls not used during actual operation and located on other units are shown in Section 4 and following. The functions of all controls are given in Sec. 3.9, "List of Controls and Adjustments."

Control names copied exactly from panel markings are capitalized thus: "MARKS Control." Control names not appearing on a panel are printed thus: "Antenna Switch."

3.1 STARTING THE EQUIPMENT

NOTE: OFF-ON Switch A (Main Switch) on the Indicator is not used on the SO-1 Radar. Instead, the power is controlled at the input to the Motor-Alternator by the START-STOP Switch for the Magnetic Controller. This switch is separately cased and mounted near the Indicator.

To start the equipment, proceed as follows:

(a) Set N-E (Normal-Emergency) Switch E to "Normal."

(b) Set Antenna Switch N to "Off."

(c) Turn GAIN Control C and INT (Intensity) Control M completely counterclockwise.

(d) Press the START Button on the separately-mounted START-STOP Switch for the Magnetic Controller.

(e) *Before proceeding further, allow at least two minutes for the tubes to warm up and for the time-delay relay on the electronic voltage regulator to operate.*

WARNING: **No high-voltage time-delay switches are included with this equipment. Sufficient time must therefore be allowed for the tube filaments to warm up, or the equipment may be damaged.**

(f) After two minutes, press START Button B, thus applying high voltage to the Transmitter. Should the overload relay drop out during starting, reset it by pushing the Overload RESET Button on the Magnetic Controller Unit.

The equipment is now ready for tuning the Receiver and adjusting the indicator controls.

Stopping the Equipment

(a) Turn INT (Intensity) Control M to its counterclockwise limit.

(b) Press STOP Button B on the Indicator.

(c) Press the STOP Button on the START-STOP Switch for the Magnetic Controller, holding it in for five seconds.

---

[1] *The Main Line Switch (not supplied) and the START-STOP Switch for the Magnetic Controller are separately mounted. When a true-bearing system is installed, a separately-mounted TRUE-RELATIVE Switch is provided for changing from true to relative bearing. The Resonance Chamber has two controls.*

3.2 OPERATING ADJUSTMENTS

With the equipment started and the Modulator operating, proceed as follows:

(a) Turn INT (Intensity) Control M clockwise until the trace is just visible on the PPI.

(b) Adjust FOCUS Control O until the sweep is as sharp and clear as possible.[1]

(c) Turn GAIN Control C clockwise to about mid-scale.

(d) Set TUNE Control H to about mid-scale.

(e) Turn MARKS Control D clockwise until marker dots of moderate brilliance appear along the trace.

(f) Set Antenna Switch N to either the "CW" (clockwise) or "CCW" (counterclockwise) position, and watch the PPI for luminous arcs which indicate signals (see Fig. 8A). (Do not confuse the signal arcs with the range marker circles.)

(g) If no signals are received, advance GAIN Control C toward maximum. If signals are still not received, turn back GAIN Control C to about three-quarters maximum and adjust TUNE Control H to vary the frequency of the local oscillator until signals are received. Then stop the Antenna on a target by means of Antenna Switch N, and carefully readjust TUNE Control H for brightest signals.[2]

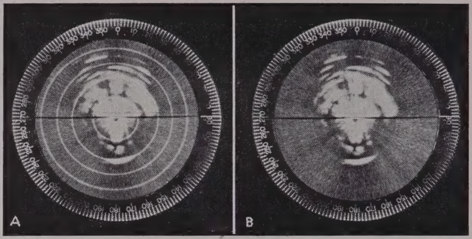


Fig. 8 — Signals as Seen on PPI Screen. (A) signals and markers; (B) signals.

In the absence of actual targets, the Resonance Chamber (Echo Box) may be used in tuning the Receiver (see Sec. 3.6).

(h) Readjust GAIN Control C and MARKS Control D for the desired relative brightness of signals and markers.

(i) Adjust INT Control M for the desired overall intensity.

(j) Readjust FOCUS Control O.

3.3 DETERMINING RANGE AND BEARING

Methods of determining range and bearing vary depending on the inclusion of the Accessory Control Unit and the type of bearing system in use.

Approximate range is estimated in all cases by the use of calibrated range markers on the PPI screen; accurate range is read from a dial on the Accessory Control Unit when used.

When only a relative-bearing system is provided, relative bearing is read from the Bearing Dial surrounding the PPI screen, using the rotatable bearing cursor (vane). When a true-bearing differential system coupled to the ship's gyro compass has been installed, either true or relative bearing can be read from the Bearing Dial, depending on the setting of the TRUE–RELATIVE Switch mounted near the Indicator. This switch couples the antenna differential gear either to the compass or to a zero-setting transformer, as desired.

---

[1] *If the sweep is found to be unstable, the trouble is probably due to faulty adjustment of the square-wave multivibrator bias in the Indicator. This adjustment is properly set at the factory and will seldom need attention on new installations. When necessary, the adjustment should be made as outlined on page 61 under Maintenance and Service.*

[2] *If the adjustment of TUNE Control H made above falls near the maximum or minimum position, reset the control to mid-scale and adjust TUNE SET Control G until signals are received. Now carefully readjust TUNE Control H for brightest signals.*

In case it is impossible to tune the Receiver with either TUNE Control H or TUNE SET Control G, as may happen when the magnetron or the local oscillator in the Receiver has been replaced, it will be necessary to retune the local oscillator cavity. This procedure is covered on page 57 in Maintenance and Service under the subheading "Tuning the Local Oscillator."

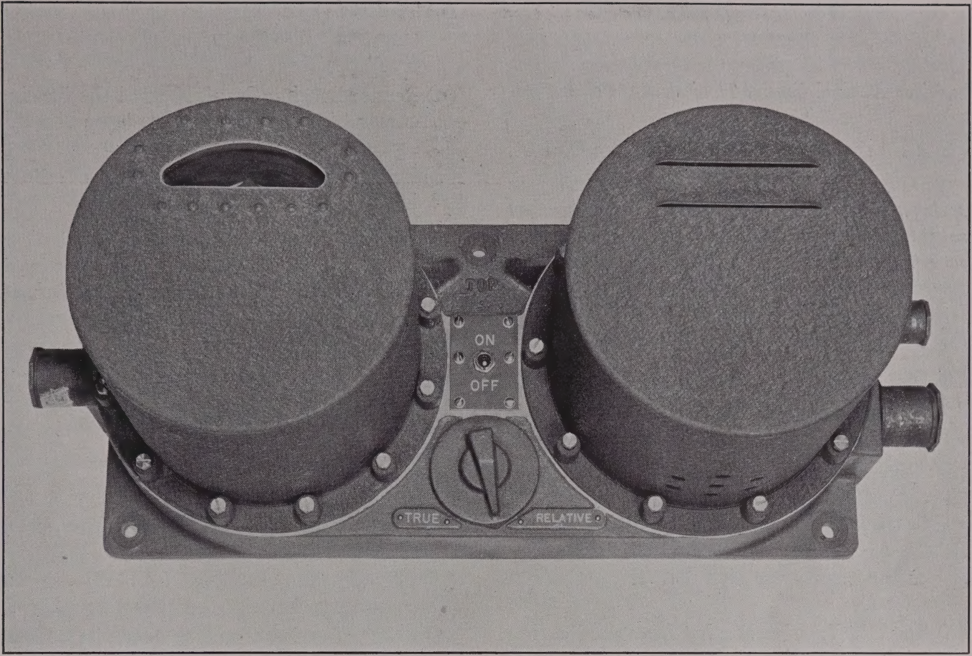


Fig. 9—Bearing Control Unit.

When a true-bearing system is installed, means are provided for producing a momentary intensification (flash) on the PPI sweep at the instant when the Antenna sweeps across the ship's bow. By noting the clockwise or counterclockwise angle existing between this ship's heading flash and the target trace, relative bearing can be read while operating on true bearing, without actually switching over the system to relative bearing.

DETERMINING APPROXIMATE RANGE

(a) Place the range markers on the PPI screen by advancing MARKS Control D until the markers appear with the desired brilliancy.

The distance represented by these markers varies with the setting of Range Switch J. With the Range Switch set on the 4-mile range position, markers are spaced at one-mile intervals; when set on the 20-mile range position, markers are spaced at 5-mile intervals; and when set on the 80-mile position, at 20-mile intervals. (See Fig. 8A.)

(b) Estimate the range of the target by reference to these markers, keeping in mind the marker intervals as determined by the setting of Range Switch J.

DETERMINING ACCURATE RANGE

The optional Accessory Control Unit (A.C.U.) is required for this purpose. The controls are shown in Fig. 7 with numbers keyed to the text. (The A.C.U. is always on when the Motor-Alternator is on.) It is assumed that the Accessory Control Unit is properly calibrated. If not, refer to "Calibrating the Accessory Control Unit," page 22.

(a) Advance MARK Control 11 (on A.C.U.) to about three-quarters maximum.

(b) Advance PILOT Control 6, which adjusts the illumination on Range Dial 14, until the dial is clearly visible.

(c) Rotate Range Crank 15 until the *accurate range mark* exactly coincides with the ranged signal.

NOTE: The accurate range mark is an artificial signal which can be shifted at will by rotating the

Range Crank. When the mark falls exactly on the target signal, the latter brightens appreciably, thus showing correct alignment. It may be necessary to readjust MARK Control 11 to obtain a clear indication.

(d) Read the accurate range on Range Dial 14.

NOTE: This dial has two scales: a 40,000-yard scale for long ranges and an 8000-yard scale for short ranges. When Range Switch J (on the Indicator) is set either to the intermediate or to the shortest range position, the corresponding scale on Range Dial 14 is automatically illuminated and the other scale does not appear.

DETERMINING RELATIVE BEARING

The following procedure applies when *only a relative-bearing system is provided:*

(a) Advance PILOT Control L (on the Indicator), which adjusts the illumination on the Bearing Dial until the dial is clearly visible.

(b) Rotate Bearing Crank K until the bearing cursor bisects the signal trace on the PPI screen.

(c) Read the relative bearing from the Bearing Dial surrounding the screen.

The following procedure applies for determining relative bearing *only when a true-bearing system has been installed:*

(a) Advance PILOT Control L (on the Indicator), which adjusts the illumination on the Bearing Dial until the dial is clearly visible.

(b) Throw the TRUE–RELATIVE Switch (mounted near the Indicator) to the "Relative" position.

(c) Rotate Bearing Crank K until the bearing cursor bisects the signal trace on the PPI screen.

(d) Read the relative bearing from the Bearing Dial surrounding the screen.

NOTE: With true-bearing systems, relative bearing can still be read while the system is operating on true bearing. This is done by noting the clockwise angle existing between the ship's heading flash and the target trace.

DETERMINING TRUE BEARING

True bearing can be read only when a true-bearing system (a.c. or d.c.) has been installed.

(a) Advance PILOT Control L until the dial is clearly visible.

(b) Throw the TRUE–RELATIVE Switch (mounted near the Indicator) to "True."

(c) Rotate Bearing Crank K until the bearing cursor bisects the signal trace on the PPI.

(d) Read the true bearing from the Bearing Dial surrounding the screen.

NOTE: The accuracy of any true-bearing system is dependent upon the accuracy of the gyro compass to which it is coupled. Any factors affecting the accuracy of the compass will similarly affect the accuracy of the true-bearing system.

3.4 EMERGENCY OPERATION

N-E (Normal-Emergency) Switch E is used to restore operation in case the Transmitter overheats, causing protective thermostat S-302 to disconnect the normal high-voltage control circuits. *The "E" (emergency) position should be used only when continued operation of the equipment is more important than damage to the Transmitter.*

To shift from normal to emergency operation, the START Button on START-STOP Switch B should be held in while turning N-E Switch E from "N" to "E."

NOTE: If by accident either the STOP Button on Switch B on the Indicator or the STOP Button on the START-STOP Switch for the Magnetic Controller is pressed, the equipment will become inoperative. If this should occur, Normal-Emergency Switch E must be turned back to "N," after which the Modulator can be restarted in the usual way.

3.5 MINOR OPERATING CONTROLS

PLAN POSITION INDICATOR

SW-L (Sweep Length) Control F is mainly used to compensate for differences in sweep amplifier tubes. It is usually adjusted so that five range markers (including the first or 0-mile marker) appear on the PPI screen. This control can also be used to expand the scale of the PPI screen. To do this, the control is adjusted so that less than five markers appear on the screen. This adjustment does not affect the range marker intervals on the Indicator or the calibration of the A.C.U.

PILOT Control L is used to control the lighting of the bearing dial to prevent masking of the PPI screen by excessive light.

CENTER Control P is used to displace the start of the sweep from its normal location at the center of the PPI screen. When the sweep starts at the exact center of the screen, signals from nearby targets are crowded into a small area, making identification difficult. Clockwise rotation of CENTER Control P displaces the start of the sweep to make traces from nearby targets occupy more of the screen area. This adjustment does not affect the range marker intervals on the Indicator or the calibration of the A.C.U.

The Humidity Indicator (below Switch B on the panel) serves as a warning when the dehydrator plugs require replacement.

ACCESSORY CONTROL UNIT

Range Crank 15 adjusts the position of the *accurate range mark* on the PPI screen to coincide with the signal to be ranged. It is mechanically coupled to Range Dial 14. This dial indicates the accurate range of a target. It has two scales, one or the other of which is automatically illuminated when Range Switch J (on the Indicator) is set to the corresponding range position. PILOT Control 6 adjusts the illumination on Range Dial 14. MARK Control 11 adjusts the brilliance of the *accurate range mark*.

LOW Control 7 and HIGH Control 8 (''8000 YD. SET'') and LOW Control 9 and HIGH Control 10 (''40,000 YD. SET'') are used to calibrate the accurate range system in the A.C.U. to the Indicator.

Line Voltmeter 13 indicates the output voltage of the 400-cycle Alternator.

SHIP HEADING FLASH Switch 3 controls the flasher circuit which is provided when a true-bearing system is installed.

IFF Switch 12 (supplied) and GAIN control 4 (not supplied) are both used to control external IFF equipment. IFF Switch 12 has three positions: ''Lock On,'' a locking position; ''Off''; and ''On,'' a non-locking or keying position.

GAIN Control 1, TUNE Control 2, TUNE Control 5, and the A.F.C.–MANUAL Control are not used on SO-1 installations, since they apply only to equipments operating on the X-band.

The HUMIDITY Indicator serves as a warning when the dehydrator plugs require replacement.

IFF CONTROL UNIT AND LINE VOLTMETER (separately mounted)

The IFF Switch (supplied), the Gain Control (not supplied), and the Line Voltmeter perform the same functions as the corresponding components on the panel of the A.C.U. When the A.C.U. is installed, the IFF Control Unit is not required.

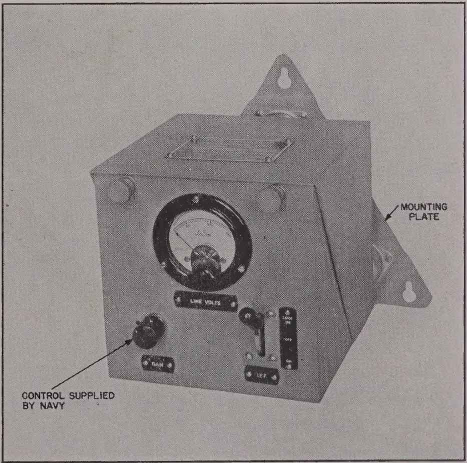


Fig. 10—IFF Control Unit and Line Voltmeter.

BEARING CONTROL UNIT
(separately mounted)

This unit is installed with true-bearing systems only. It provides a TRUE–RELATIVE Switch for changing from true to relative bearing, and an ON-OFF Switch for controlling the servo amplifier in the unit.

MAIN LINE SWITCH
(separately mounted)

This switch controls the ship's d.c. supply to the Motor-Alternator. It is opened when the equipment is secured and during certain servicing operations.

3.6 USE OF RESONANCE CHAMBER

In the absence of actual targets or at the discretion of the operator, the Receiver can be tuned with the aid of the Resonance Chamber (Echo Box). The Echo Box must be tuned before use as follows:

(a) With the Transmitter radiating, turn the cam lever to the horizontal position pointing toward the neon indicator bulb.

(b) Rotate the adjusting nut on the Echo Box until resonance (correct tuning) is indicated by maximum glow of the neon lamp.

(c) Set Range Switch J to the shortest range and adjust TUNE Control H for maximum signal on the screen.

NOTE: This signal appears on the PPI as a bright line extending from the center of the screen to about the two-mile position (see Fig. 11). The Receiver should be tuned for maximum length of this line (see Fig. 11B).

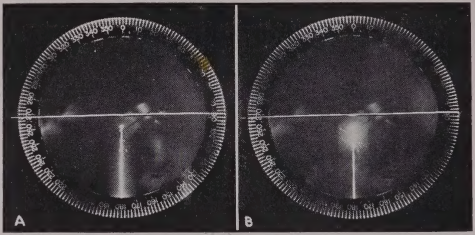


Fig. 11—Tuning with Resonance Chamber (Echo box). (A) Receiver detuned; (B) Receiver tuned.

(d) After tuning the Receiver, be sure to throw the cam lever on the Echo Box to the opposite horizontal position, thus detuning the latter and preventing masking of actual signals.

3.7 CALIBRATING THE ACCESSORY CONTROL UNIT

The A.C.U. should not be calibrated until the equipment has been in operation for at least 30 minutes. The calibration should be checked every few hours.

CALIBRATING THE 4-MILE RANGE

(a) Set Antenna Switch N (on the Indicator) to "Off" and turn GAIN Control C to its counterclockwise limit.

(b) Advance MARKS Control D until small markers appear on the PPI screen. Adjust FOCUS Control O for maximum sharpness of these markers.

(c) With Range Switch J set on the 4-mile position, adjust SW-L (Sweep Length) Control F so that at least five markers (including the first or 0-mile marker) appear on the screen.

(d) Adjust MARK Control 11 for proper brilliance of the *accurate range mark*. This is best done when the mark and range marker do not coincide.

(e) Rotate Range Crank 15 until Range Dial 14 reads exactly 2000 yards. (2000 yards equals one Radar mile.)

(f) Adjust LOW Control 7 ("8000 YD. SET") until the mark and the one-mile range marker exactly coincide.

(g) Rotate the Range Crank until the Range Dial reads exactly 8000 yards, then adjust

HIGH Control 8 (''8000 YD. SET'') until the mark and the 4-mile marker coincide.

(h) Repeat steps (f) and (g) several times, since these two adjustments are reactive.

CALIBRATING THE 20-MILE RANGE

(a) Set Range Switch J to the 20-mile position, and rotate the Range Crank until the Range Dial reads exactly 10,000 yards.

(b) Adjust LOW Control 9 (''40,000 YD. SET'') until the mark and the 5-mile range marker coincide.

(c) Rotate the Range Crank until the Range Dial reads 40,000 yards, then adjust HIGH Control 10 (''40,000 YD. SET'') until the mark coincides with the 20-mile marker.

(d) Repeat steps (b) and (c) several times since the two adjustments are reactive.

The A.C.U. is now calibrated and ready for use in determining accurate ranges.

While the accurate ranging system may be used with Range Switch J on the 80-mile range, its use is limited to 20 miles since the mark will cover only the first quarter of the sweep.

3.8 NOTES ON OPERATION

RANGE AND PERFORMANCE

The maximum range of the equipment is normally slightly greater than the optical horizon as viewed from the Antenna. The strength of the received echo generally depends upon the size and shape of the target, its distance and height, and the material of which it is made. No difficulty should be experienced in receiving echoes from small objects such as very small craft, periscopes, bell buoys, etc., at moderate ranges; while larger objects such as large ships, land, aircraft, etc., usually give strong echoes at distances up to and exceeding the optical horizon.

SKILL OF OPERATOR

Success in *identifying* echo signals depends in large measure upon the skill of the operator. A well-trained operator is able to pick out weak echoes that would otherwise go unnoticed; and he can often identify the nature of the target from the echo trace. In addition, he can often determine the approximate course and speed of moving objects.

SPECIAL PHENOMENA

The SO-1 Radar, like other Radar equipment, is subject to certain peculiar phenomena. Rain squalls and clouds often produce a lace-like echo on the PPI as the result of their imperfect reflection characteristics. This type of echo is readily recognized by the skilled operator and may often provide worth-while weather information.

When nearby targets are present, multiple reflections sometimes occur between the ship and the target. The result is a rapidly damped series of echoes spaced by the interval between the ship and the target. This effect causes no confusion to the skilled operator.

INDIVIDUAL OPERATING METHODS

Methods of operation will vary with individuals, one method being perhaps as good as another. At the factory, for example, test men prefer to set INT Control M so that a very faint trace of the radial sweep shows when GAIN Control C and MARKS Control D are fully retarded. When signals are received, GAIN Control C is advanced, resulting in nearly optimum screen brilliancy.

Most operators like to work with GAIN Control C far enough advanced to produce strong signals with the ''snow'' effect barely visible on the PPI. This insures a clean screen which aids in the recognition of faint signals.

When searching for faint or distant targets, MARKS Control D should be turned back until the range markers are barely visible or invisible. Faint targets will then show up clearly on the PPI. When targets are fairly bright, range markers may be left turned up.

Unsteady or weak targets can be brightened on the PPI by sector scanning. This is done by snapping Antenna Switch N from ''CW'' to ''CCW'' and back again every few moments, thus sweeping the antenna beam back and forth over a small sector of the horizon. *Owing to tactical considerations, sector scanning should be employed only as directed by the Radar Officer.*

3.9 LIST OF CONTROLS AND ADJUSTMENTS

Control names copied exactly from panel markings are capitalized thus: "MARKS Control." Control names not appearing on a panel are printed thus: "Antenna Switch."

Marking	*Symbol*	*Resistance (Max.) (Ohms)*	*Function*	*Location*
			Motor-Alternator-Modulator	
R-113	R-113	500	Excitation to #1 alternator field	Regulator fuse panel
R-114	R-114	25	Speed Control	Fuse and resistor panel
R-115	R-115	100	Speed Control	Fuse and resistor panel (on some early units only)
R-117	R-117	10,000	Adjusts voltage regulator	Regulator panel, right side
R-125	R-125	225	Adjusts voltage regulator filter	Fuse and resistor panel (not on early models)
			Plan Position Indicator	
CENTER	R-421	3,000	Adjusts PPI spot centering	Knob on panel, lower right corner
SW-L (Sweep Length)	R-423	500	Adjusts sweep speed	Screwdriver adjustment on panel, left center
R-429	R-429	10,000	Controls multivibrator bias	Screwdriver adjustment on chassis, left front
PILOT	R-441	15	Controls pilot light intensity	Knob on panel, lower left corner
MARKS	R-455	10,000	Controls marker intensity	Knob on panel, upper right corner
INT (Intensity)	R-459	15,000	Controls PPI intensity	Knob on panel, lower left side
FOCUS	R-468	15,000	Controls PPI focus	Knob on panel, lower right side
TUNE SET	R-494	20,000	Controls receiver tuning (dual) by coarse adjustment of repeller plate voltage of local oscillator	Screwdriver adjustment on panel, right center
TUNE	R-497	100,000	Controls receiver tuning by vernier adjustment of repeller plate voltage of local oscillator	Knob on panel, right center
GAIN	R-498	10,000	Controls receiver gain	Knob on panel, upper right side
Range 4-20-80 (Miles)	S-401		Selects range	3-position switch on panel, center
CCW-OFF-CW (counterclockwise—clockwise)	S-402		Controls direction of antenna rotation	3-position lever switch on panel, lower center
OFF-ON	S-403		Main switch for equipment	Knob on panel, upper left corner

3.9 LIST OF CONTROLS AND ADJUSTMENTS (Cont.)

Marking	*Symbol*	*Resistance (Max.) (Ohms)*	*Function*	*Location*
N-E (Normal — Emergency)	S-404		Controls transmitter plate voltage for emergency operation	Knob on panel, left center
STOP-START	S-405		Main switch for Modulator	Momentary push-button switch on panel, upper left side
Bearing Crank (Not marked)			Adjusts bearing cursor	Hand crank on panel, lower right center
Humidity			Indicates condition of dehydrator plugs	Transparent plug on panel, left center
		Accessory Control Unit		
8000 YD. SET: LOW	R-701	5,000	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment on panel, lower left
40,000 YD. SET: LOW	R-704	5,000	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment on panel, lower right
8000 YD. SET: HIGH	R-706	5,000	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment on panel, lower left
40,000 YD. SET: HIGH	R-707	5,000	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment on panel, lower right
Range Crank	R-716	20,000	Adjusts position of accurate range mark	Hand crank on panel, lower center
Range Dial			Indicates accurate range	On panel, upper center
MARK	R-743	5,000	Controls intensity of accurate range mark	Knob on panel, lower right
PILOT	R-744	50	Controls pilot light intensity	Knob on panel, lower left
HUMIDITY			Indicates condition of dehydrator plugs	Transparent plug on panel, right center
IFF	S-703		Switches IFF equipment	On panel, lower right
SHIP HEADING FLASH	S-704		Controls ship heading flash	Toggle switch on panel, upper right
GAIN* (Not supplied)	R-755		Controls IFF gain	Screwdriver adjustment on panel, right center
TUNE*	S-701		Switches Meter M-702 from line voltage to echo box resonance indication	On panel, left center
TUNE*	S-705		Controls tuning of echo box	On panel, lower left
AFC–MANUAL*	S-706		Switches automatic frequency control	On panel, upper right
		IFF Control Unit and Line Voltmeter		
GAIN (Not supplied)	R-1204		Controls gain of IFF receiver	IFF Control Unit; front panel, lower left
IFF	S-1201		Controls IFF equipment	IFF Control Unit; front panel, lower right

**Omitted from SO-1 Equipments; used only with equipments operating on the X-band.*

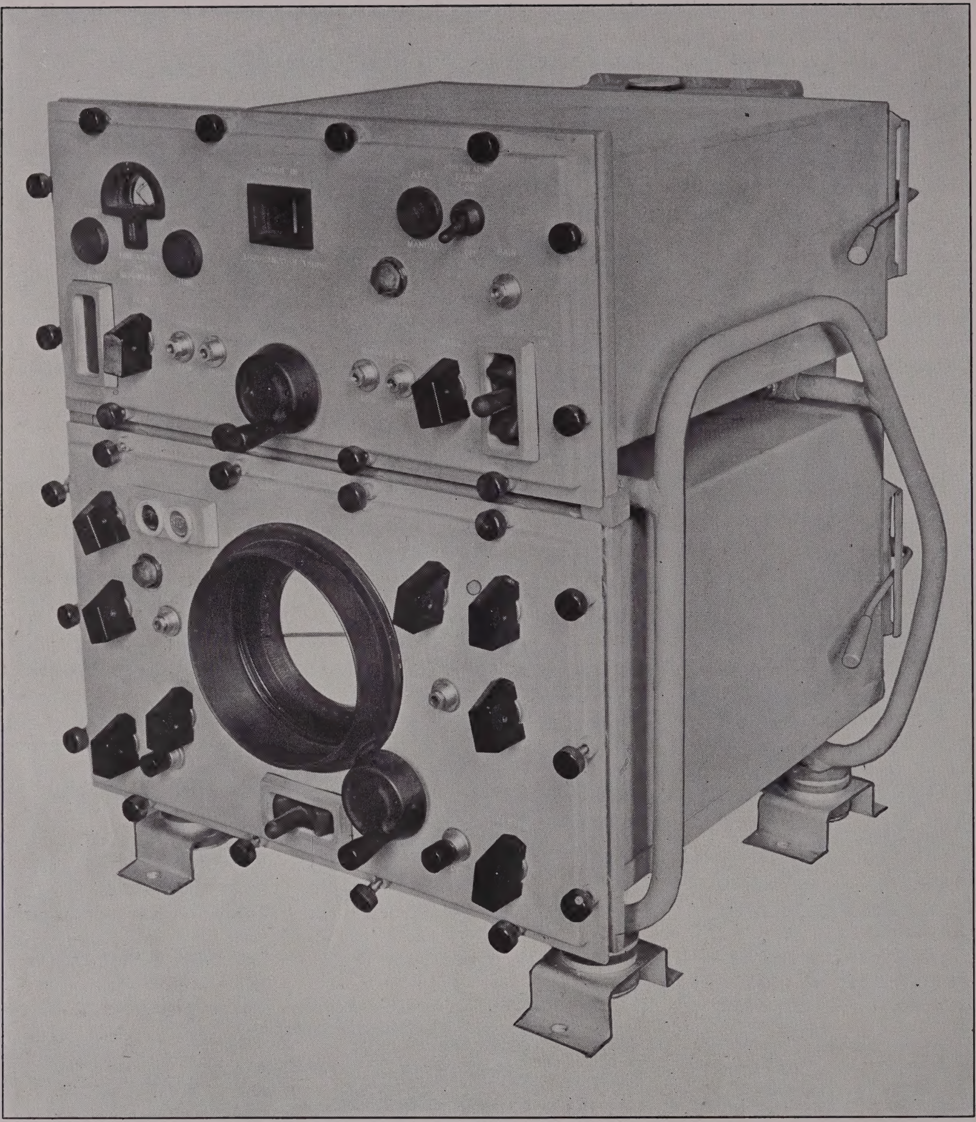


Fig. 12 — Accessory Control Unit Mounted in Cradle over Plan Position Indicator.

Section 4—Maintenance and Service

4.1 PREVENTIVE MAINTENANCE

The best kind of maintenance is Preventive Maintenance. This is proved by a digest of service reports received on SO-Series Radar Equipment. Preventive Maintenance includes periodic lubrication, inspection, and adjustment of the equipment. These, covered in the following pages, should be thoroughly studied.

The key and guide to this program is the Routine Maintenance Table following this page. All operations listed should be performed at least as often as the table indicates.

Through the careful following of this schedule, troubles can be detected at the start and remedied before they cause a real breakdown at a time when a breakdown might be disastrous. Major replacements can thus be avoided. The old saying, "A stitch in time . . . " is especially true of Radar maintenance.

Instructions for carrying out all routine maintenance operations, arranged by units, are given later in this section. Many special maintenance operations are also described.

4.2 LOCATING TROUBLE

QUICK CHECK-UP AFTER EQUIPMENT FAILURE

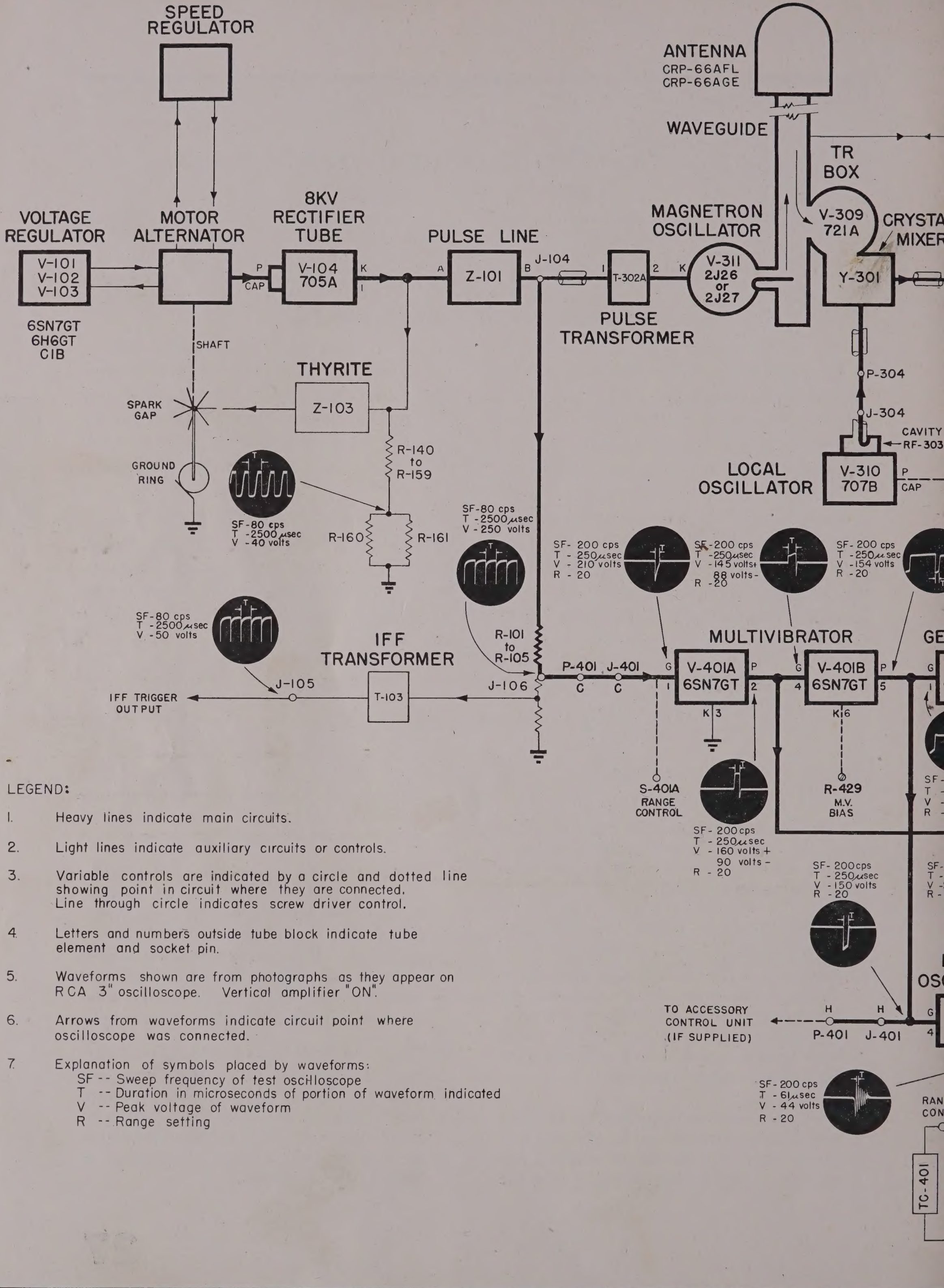
If the equipment should fail while on active duty, the operator should attempt to get it running again by carrying out the following quick check-up procedure:

(a) Turn up the boot over the waveguide coupler and check to make sure that no water is trapped on top of the Plexiglas cover. Water at this point will prevent the outgoing energy from reaching the Antenna. Allow the wind to blow out the water, wipe with a clean dry cloth, and return the boot to its original position.

(b) Check the water trap attached to the spark gap exhaust manifold on the Motor-Alternator. This trap should be emptied frequently, as water may overflow into the spark gap and prevent firing. Be careful in disposing of this water, since it may contain nitric acid formed by water combining with the exhaust gases from the gap.

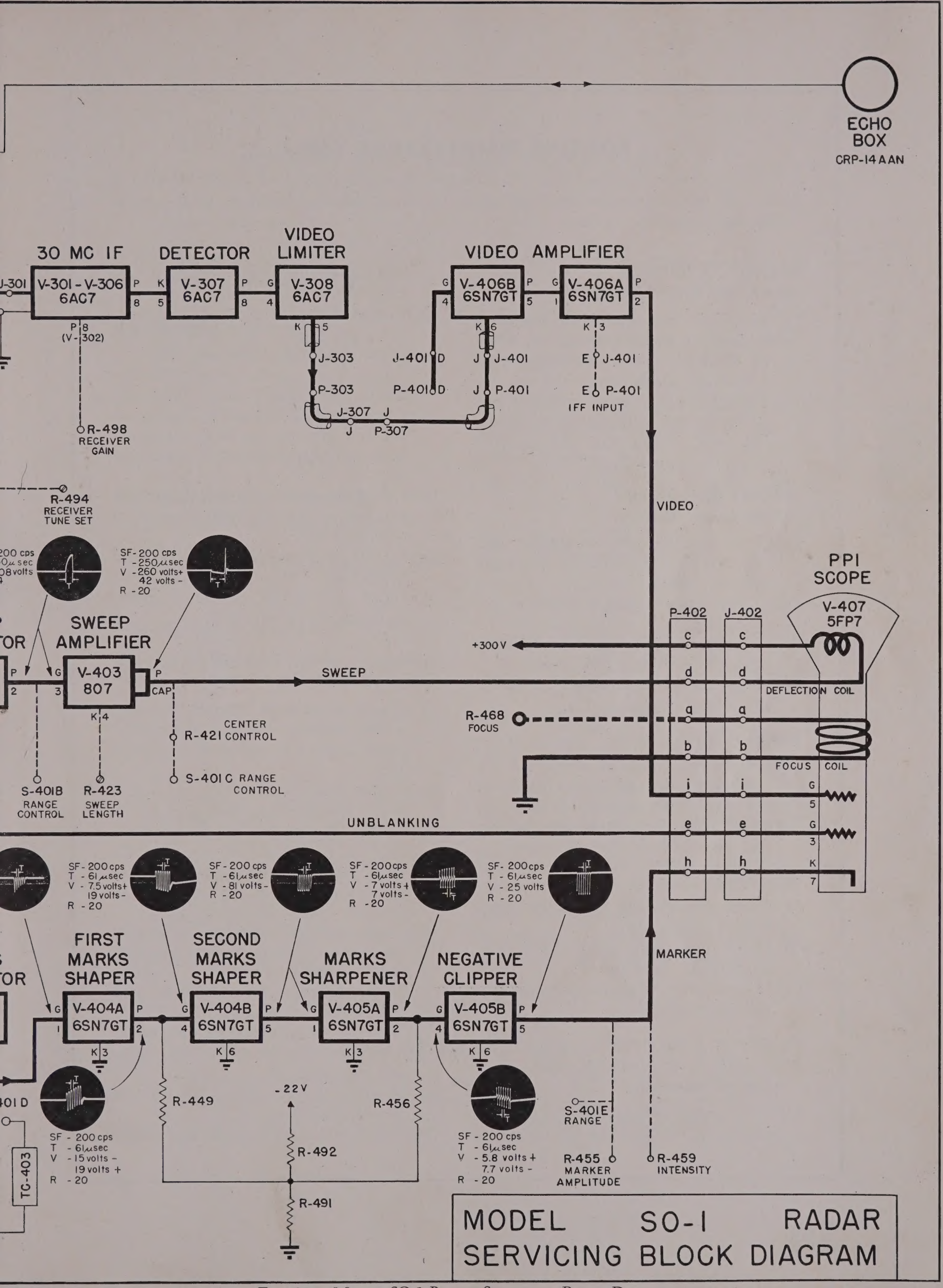
(c) Check the three interlocks, located one each in the Motor-Alternator-Modulator, the Rectifier Power Unit, and the Transmitter-Receiver. These may open under gunfire or vibration. By striking a firm blow on each unit case near the interlock, interlocks can often be reseated and normal operation of the equipment restored.

(d) Check the fuses (see page 38, "Fuse Locations"). *Blown fuses are the most likely cause of failure.* Before replacing fuses, remember to turn off the Main Line Switch to avoid injury from high voltage. Remember to close the switch before attempting to operate the equipment.


SPEED REGULATOR
ANTENNA
CRP-66AFL
CRP-66AGE
WAVEGUIDE
TR BOX
V-309
721A
CRYSTA
MIXER
MAGNETRON OSCILLATOR
V-311
2J26
or
2J27
Y-301
VOLTAGE REGULATOR
V-101
V-102
V-103
6SN7GT
6H6GT
C1B
MOTOR ALTERNATOR
8KV RECTIFIER TUBE
V-104
705A
P
CAP
K
I
PULSE LINE
A
Z-101
B
J-104
1
T-302A
2
K
PULSE TRANSFORMER
SHAFT
THYRITE
Z-103
SPARK GAP
GROUND RING
R-140
to
R-159
R-160
R-161
SF-80 cps
T -2500 μsec
V -40 volts
SF-80 cps
T -2500 μsec
V - 250 volts
P-304
J-304
CAVITY
RF-303
LOCAL OSCILLATOR
V-310
707B
P
CAP
SF- 200 cps
T - 250 μsec
V - 210 volts
R - 20
SF-200 cps
T -250 μsec
V -145 volts+
88 volts-
R -20
SF- 200 cps
T -250 μsec
V -154 volts
R -20
T
SF-80 cps
T -2500 μsec
V -50 volts
IFF TRANSFORMER
R-101
to
R-105
MULTIVIBRATOR
GE
J-105
IFF TRIGGER OUTPUT
T-103
J-106
P-401
J-401
C
C
G
1
V-401A
6SN7GT
P
2
K 3
G
4
V-401B
6SN7GT
P
5
K 6
S-401A
RANGE CONTROL
R-429
M.V. BIAS
SF- 200 cps
T - 250 μsec
V - 160 volts +
90 volts -
R - 20
SF- 200cps
T - 250 μsec
V - 150 volts
R - 20
OS
TO ACCESSORY CONTROL UNIT (IF SUPPLIED)
H
H
P-401
J-401
G
4
SF - 200 cps
T - 61 μsec
V - 44 volts
R - 20
RAN
CON
TC-401

LEGEND:

1. Heavy lines indicate main circuits.
2. Light lines indicate auxiliary circuits or controls.
3. Variable controls are indicated by a circle and dotted line showing point in circuit where they are connected. Line through circle indicates screw driver control.
4. Letters and numbers outside tube block indicate tube element and socket pin.
5. Waveforms shown are from photographs as they appear on RCA 3" oscilloscope. Vertical amplifier "ON".
6. Arrows from waveforms indicate circuit point where oscilloscope was connected.
7. Explanation of symbols placed by waveforms:
   - SF -- Sweep frequency of test oscilloscope
   - T -- Duration in microseconds of portion of waveform indicated
   - V -- Peak voltage of waveform
   - R -- Range setting


ECHO BOX
CRP-14AAN
30 MC IF
DETECTOR
VIDEO LIMITER
VIDEO AMPLIFIER
J-301
V-301 - V-306
6AC7
P 8
K 5
V-307
6AC7
P 8
G 4
V-308
6AC7
K 5
G 4
V-406B
6SN7GT
P 5
G 1
V-406A
6SN7GT
P 2
P 8 (V-302)
J-303
P-303
J-307 J
J P-307
J-401 D
P-401 D
K 6
J J-401
J P-401
K 3
E J-401
E P-401
IFF INPUT
R-498
RECEIVER GAIN
R-494
RECEIVER TUNE SET
VIDEO
200 cps
0µsec
08 volts
SF-200 cps
T -250µsec
V -260 volts+
42 volts -
R -20
TOR
SWEEP AMPLIFIER
P 2
G 3
V-403
807
P CAP
K 4
SWEEP
+300V
CENTER
R-421 CONTROL
S-401C RANGE CONTROL
S-401B
RANGE CONTROL
R-423
SWEEP LENGTH
PPI SCOPE
V-407
5FP7
P-402
J-402
c
d
a
b
i
e
h
DEFLECTION COIL
R-468
FOCUS
FOCUS COIL
G 5
G 3
K 7
UNBLANKING
SF-200 cps
T - 61µsec
V - 7.5 volts+
19 volts -
R - 20
SF-200 cps
T - 61µsec
V - 81 volts -
R - 20
SF-200cps
T - 61µsec
V - 7 volts +
7 volts -
R - 20
SF- 200cps
T - 61µsec
V - 25 volts
R - 20
FIRST MARKS SHAPER
SECOND MARKS SHAPER
MARKS SHARPENER
NEGATIVE CLIPPER
TOR
MARKER
G 1
V-404A
6SN7GT
P 2
K 3
G 4
V-404B
6SN7GT
P 5
K 6
G 1
V-405A
6SN7GT
P 2
K 3
G 4
V-405B
6SN7GT
P 5
K 6
401 D
TC-403
SF - 200 cps
T - 61µsec
V - 15 volts -
19 volts +
R - 20
R-449
-22V
R-492
R-491
R-456
SF - 200 cps
T - 61µsec
V - 5.8 volts +
7.7 volts -
R - 20
S-401E
RANGE
R-455
MARKER AMPLITUDE
R-459
INTENSITY

MODEL SO-1 RADAR
SERVICING BLOCK DIAGRAM

ROUTINE MAINTENANCE TABLE

All maintenance operations outlined below should be performed at least as often as indicated. Detailed instructions are given under appropriate headings in the pages following this table.

I. ONCE A WEEK:

Motor-Alternator-Modulator

(a) Blow out the modulator compartment with *dry* compressed air. Wipe off the high-voltage insulators with a clean dry cloth.
(b) Inspect the glass water trap attached to the bottom of the spark gap housing, and empty out accumulated water (see pages 41 and 45).

Antenna Assembly and Transmitter-Receiver

(a) Drain water from waveguide and clean off salt deposits on Plexiglas coupling choke.
(b) Check Transmitter for proper waveguide alignment.
(c) Check transmitter case and leveling screws for corrosion.
(d) Check transmitter-receiver cables for sharp bends (see page 13).

Rectifier Power Unit

(a) Blow out interior of unit with *dry* compressed air, and wipe with cloth.
(b) Check cables for damage (see page 13).
(c) Check tubes for seating and locking (see page 14).

Miscellaneous

(a) Check special coax cables for sharp bends (see page 13).
(b) Check operating controls for proper functioning (see page 17).
(c) Make additional checks requested by skipper or technician.

II. ONCE A MONTH:

Motor-Alternator-Modulator and Magnetic Controller

(a) Check cable connectors. Check all cables and terminations for tightness and cables for proper dressing (see page 13).
(b) Inspect motor-alternator, commutators, slip rings, and brushes, also spark gap brushes (see page 41).
(c) Check spark gap for proper spacing, timing, and condition of electrodes. Clean air filter (fire trap). Check timing and gap spacing locks for tightness, and re-seal these locks (see page 41).
(d) Check alternator output voltage, and readjust voltage regulator if necessary (see page 50).
(e) Inspect and burnish all relays and contactors.
(f) Clean and polish ferrule resistors, fuses, clips and interlock.

Antenna Assembly, Transmitter-Receiver and Junction Box

(a) Check waveguide shutter for free action. Inspect blower motor and replace brushes if necessary (see page 59).
(b) Check dehydrator plugs in Transmitter and Junction Box.
(c) Check TR and local oscillator cavities for tightness; retune TR box, local oscillator, and crystal mixer; and make sure that tuning plugs are properly locked (see page 55).
(d) Check terminal tubes and pressurizing caps on Transmitter and Junction Box (see pages 11 and 12).
(e) Check Antenna for alignment and loose bolts (see page 62).
(f) Check cable terminations (including echo box cable connector) for tightness (see page 13).
(g) Check antenna space heaters for proper operation.
(h) Inspect and clean junction box relays.

ROUTINE MAINTENANCE TABLE (Cont.)

(i) Every 300 hours of operation, replace the duplexing tube in the TR box, regardless of its condition, and discard the old tube. Clean the fins of the new tube before installing (see page 55).

Rectifier Power Unit

(a) Clean interlock, ferrule resistors, fuse and clips.
(b) Check cable terminations for tightness; check cable dressings (see page 13).
(c) Burnish relay contacts.

Resonance Chamber (*Echo Box*)

(a) Check cable connector and neon bulb for tightness.
(b) Check tuning nut and cam lever for binding.

Plan Position Indicator

(a) Inspect dehydrator plugs.
(b) Check tubes for tightness (see page 14).
(c) Inspect J-401 and P-401 for corrosion (see page 13).
(d) Burnish relay contacts.
(e) Check for loose bolts.
(f) Clean and polish ferrule resistors, fuses, and clips.
(g) Check rotating system of PPI deflection coil for binding (see page 61).
(h) Check incoming cables for damage. Check terminal tubes and pressurizing caps (see page 13).
(i) Check packing gland around each panel control for tightness.
(j) Lubricate the small PPI drive gear shaft bearings with a few drops of Univis P48 oil.
(k) Adjust bearing cursor eccentric if used (see page 61).

IFF Control Unit

(a) Blow out interior of unit with compressed air.
(b) Zero-set the voltmeter.
(c) Check cable terminations for tightness (see page 13).

Miscellaneous

(a) Check all tubes for tightness (see page 14).

III. ONCE A YEAR:

Motor-Alternator-Modulator

(a) Dismantle and inspect the Motor-Alternator, and replace worn parts (see page 41).
(b) Dismantle the rotating electrode assembly of the spark gap, and clean and repack bearings (see page 41).

Antenna Assembly

(a) Dismantle and clean the Antenna Assembly; inspect and replace worn parts, including main spindle bearings, main drive gears, gear reduction box, and drive motor. Lubricate all parts (see page 61).
(b) Dismantle and inspect synchro. Remount and align (see page 62).

Plan Position Indicator

(a) Dismantle and inspect synchro. Remount and align (see page 59).

USE OF RADAR LOG

A Radar log is provided with each equipment, to be kept in a log holder mounted on the cover of the Rectifier Power Unit. The log should be posted whenever the equipment is serviced or modified in any way.

VOLTAGE MEASUREMENTS

Model SO-1 Radar Equipment

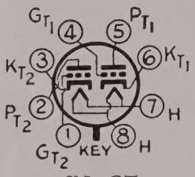
Measurements made from the designated terminals to ground using a 20,000-ohms-per-volt meter *and with the Transmitter not radiating*

Plan Position Indicator CRP-55ADQ

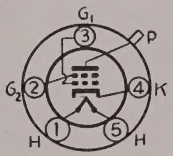
Tube	*Type*	*Pin 1 Grid A*	*Pin 2 Plate A*	*Pin 3 Cath. A*	*Pin 4 Grid B*	*Pin 5 Plate B*	*Pin 6 Cath. B*	*Pin 7 A. C.*	*Pin 8 Heater*
V-401	6SN7-GT	− 6	115	0	115	320	180	0	6.3
V-402	6SN7-GT	−22	− 22	−22	1.6	55	0.15	0	6.3
V-403	807	0 (heater)	320 (grid 2)	−23 (grid 1)	10 (cathode)	6.3 a.c. (heater)	310 (cap) (plate)	—	—
V-404	6SN7-GT	+0.1	19	0	−0.7	60	0	0	6.3
V-405	6SN7-GT	+0.1	85	0	−0.1	65	0	0	6.3
V-406	6SN7-GT	−0.2	65	0.3	−0.5	70	0.1	0	6.3
V-407	5FP7	—	6.3 a.c. to pin 8 (heater)	110 (grid 2)	—	65 (grid 1)	5000 (cap) (plate)	95 (cathode)	6.3 a.c. to pin 2 (heater)
V-408	5U4-G	—	330 (heater)	—	300 a.c. (plate)	—	300 a.c. (plate)	—	330 (heater)

NOTE: With normal 115-volt 400-cycle input, voltages may vary ±10% from values shown. All voltages measured with Indicator not triggered, no signals applied, and controls set as follows:

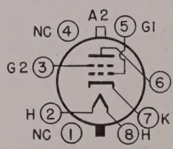
M.V. Bias R-429 set to clockwise limit.
Sweep Length R-423 to counterclockwise limit.
Center R-421 to counterclockwise limit.
Intensity R-459 to counterclockwise limit, and Range Switch S-401 to "4."



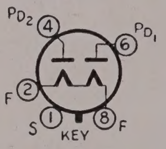
6SN7-GT



807



5FP7



5U4-G

Rectifier Power Unit

Terminal	*Voltage*	*Terminal*	*Voltage*	*Terminal*	*Voltage*	*Terminal*	*Voltage*
1	0	7	0	11 & 21	0	19	0
2	0	9	0	12 & 35	0	23	0
3	0	10	0	27 & 30	−255 d.c.	24	0
4	0	13	0	28 & 31	0	25	0
5	0	22	0	8 & 20	0	32	115 d.c.
36	0	26	−360 d.c.	6 & 18	0	33	230 d.c.
46	0	29	+105 d.c.	14 & 17	230 d.c.	34	0
47	0	not used		15 & 16	−300 d.c.	not used	

NOTE: The above values are subject to variation with other than 115-volt 400-cycle power. The voltages at 15 and 16 are dependent on the adjustment of the TUNE SET Control. The voltages at 14 and 17 are dependent on the setting of the GAIN Control. The above values were taken from an equipment having an ungrounded 115-volt d.c. source.

VOLTAGE MEASUREMENTS

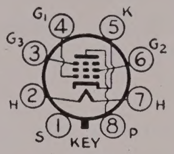
Model SO-1 Radar Equipment

Measurements made from the designated terminals to ground using a 20,000-ohms-per-volt meter *and with the Transmitter not radiating*

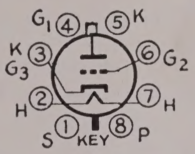
TRANSMITTER-RECEIVER CRP-43ABK-1 and Receiver CRP-46ACA-1

Tube	*Type*	*Pin 1 Shield*	*Pin 2 Heater*	*Pin 3 Suppressor*	*Pin 4 Grid*	*Pin 5 Cathode*	*Pin 6 Scr. Grid*	*Pin 7 Heater*	*Pin 8 Plate*
V-301	6AC7	0	0	0	0	0.65	105	6.3	95
V-302	6AC7	0	0	0	0	0.65	105	6.3	95
V-303	6AC7	0	0	0	0	0.65	105	6.3	95
V-304	6AC7	0	0	0	0	0.65	105	6.3	95
V-305	6AC7	0	0	0	0	0.65	105	6.3	95
V-306	6AC7	0	0	0	0	1.0	105	6.3	215
V-307	6AC7	—	—	—	–10.5	0	–10.5	6.3	–10.5
V-308	6AC7	0	0	0	0	1.0	120	6.3	225
V-309	721-A	(cap) keep-alive voltage 220 volts, r.m.s., 400 c.p.s.							
V-310	707-B	—	0	–250 (cathode)	—	—	0 (grid)	6.3	315 (cap)

NOTE: With normal 115-volt 400-cycle input, voltages may vary ±10% from values shown. All voltages measured with Gain Control R-498 at maximum and Tune Set Control R-494 at counterclockwise limit.



6AC7

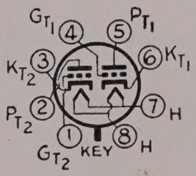


707-B

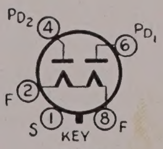
ACCESSORY CONTROL UNIT CRP-23ADZ.

Tube	*Type*	*Pin 1 Grid A*	*Pin 2 Plate A*	*Pin 3 Cath. A*	*Pin 4 Grid B*	*Pin 5 Plate B*	*Pin 6 Cath. B*	*Pin 7 Heater*	*Pin 8*
V-701	6SN7-GT	0 or neg.	125	0	37	37	37	6.5	0
V-702	6SN7-GT	24	210	45	37	140	45	6.5	0
V-703	6SN7-GT	0	75	0	0	210	12	6.5	0
V-704	5U4-G	—	325 d.c. (fil.)	—	310 a.c. (plate)	—	310 a.c. (plate)	—	325 d.c. (fil.)
V-705	VR105-30	—	105	—	—	215	—	—	—
V-706	VR105-30	—	0	—	—	105	—	—	—
V-708	6-4	—	6.0 a.c.	—	—	—	—	12 a.c.	—
V-711	6-4	—	12 a.c.	—	—	—	—	6.4 a.c.	—

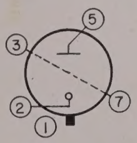
NOTE: With normal 115-volt 400-cycle input, voltages may vary ±10% from values shown. All voltages measured with the A.C.U. not triggered, all Limit Set Controls at counterclockwise limit, and Range Dial at zero.



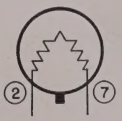
6SN7-GT



5U4-G



VR105-30



6-4

TEST POINT LOCATIONS

Model SO-1 Radar Equipment

All locations are described looking at the top side with units positioned as follows: Motor-Alternator, motor at left; Modulator, open side toward operator; Transmitter-Receiver, receiver strip toward operator; Plan Position Indicator, panel toward operator. This system is maintained for underside locations.

“B”	Pulse Cable Terminal	right rear center of top
J–105	“ “ “	right rear center of top
J–106	“ “ “	right rear center of top
J–301	Transmitter-Receiver:	right end of receiver strip
J–302	“ “	right end of receiver strip
J–303	“ “	left end of receiver strip
J–304	“ “	right side, connecting into local oscillator cavity
J–307	“ “	in junction box beneath unit
J–401	Plan Position Indicator:	in junction box at rear of unit
J–402	“ “ “	behind PPI tube socket
L–101	Modulator Compartment:	upper right
P–301	Transmitter-Receiver:	right end of receiver strip
P–303	“ “	left end of receiver strip
P–304	“ “	right side, connecting into local oscillator cavity
P–307	“ “	below receiver strip
P–401	Plan Position Indicator:	in junction box at rear of unit
P–402	“ “ “	behind PPI tube socket
R–101—R–105	Modulator Compartment:	right rear
R–140—R–161	“ “	upper center
R–421	Plan Position Indicator:	CENTER Control, front panel, lower right
R–423	“ “ “	SW–L (Sweep Length) Control, screwdriver adjustment, front panel, left center
R–429	“ “ “	MV (Multivibrator) Bias Control, left front of chassis
R–449	“ “ “	center front on left side sub-panel beneath chassis
R–455	“ “ “	MARKS Control, front panel, upper right
R–456	“ “ “	front of left side sub-panel beneath chassis
R–459	“ “ “	INT (Intensity) Control, front panel, lower left

TEST POINT LOCATIONS (Cont.)

Model SO-1 Radar Equipment

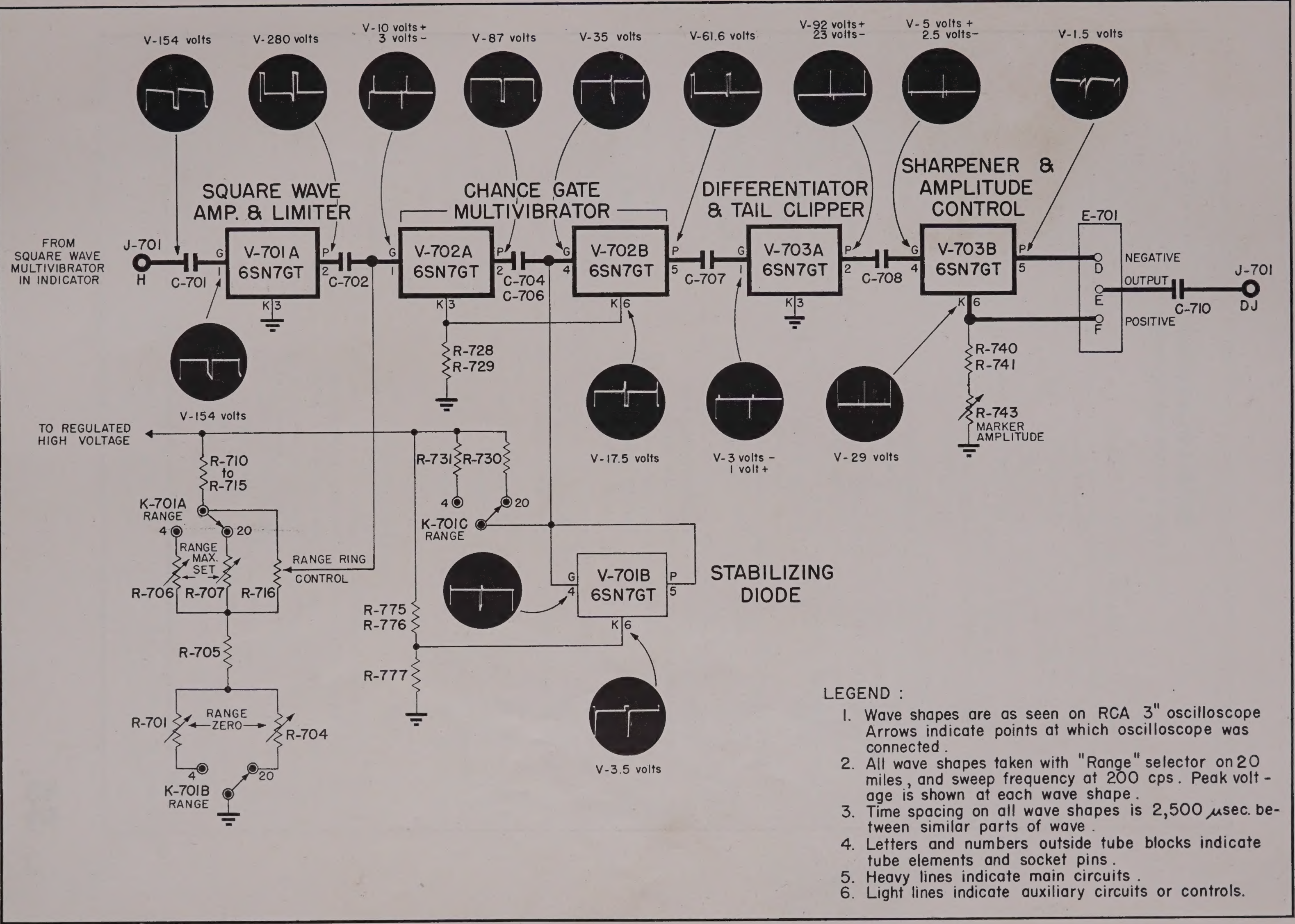
R–468	Plan Position Indicator:	FOCUS Control, front panel, lower right
R–491	" " "	right rear of center sub-panel beneath chassis
R–492	" " "	right rear of center sub-panel beneath chassis
R–494	" " "	TUNE SET Control, screwdriver adjustment, front panel, right center
R–497	" " "	TUNE Control, front panel, right center
R–498	" " "	GAIN Control, front panel, upper right
S–401	" " "	Range Switch, front panel, lower left: A — rear wafer B — 3rd from front C — rear wafer D — 2nd from front E — front wafer F — 2nd from front
S–107	Drive Motor	end of motor
T–103	" "	lower right
T–302A	Transmitter-Receiver:	left rear
TC–401	Plan Position Indicator:	left front of chassis, under shield (control under chassis)
TC–402	" " "	left front of chassis, under shield (control under chassis)
TC–403	" " "	left front of chassis, under shield (control under chassis)
V–101	Voltage Regulator Compartment:	left side
V–102	" " "	left side
V–103	" " "	left side
V–104 (SO-a)	Modulator Compartment	left center
V–301—V–306	Transmitter-Receiver:	first six tubes on receiver strip, right to left
V–307	" "	7th tube from right on receiver strip
V–308	" "	8th tube from right on receiver strip
V–309	" "	in TR box, r.f. system
V–310	" "	right side (local oscillator)
V–311	" "	center of unit, near magnet
V–401	Plan Position Indicator:	4th tube from front, left side
V–402	" " "	3rd tube from front, left side
V–403	" " "	5th tube from front, left side
V–404	" " "	2nd tube from front, left side
V–405	" " "	front tube, left side
V–406	" " "	rear tube, left side
VR–1101	Voltage Regulator:	separately mounted in box on bulkhead
Y–301	Transmitter-Receiver:	on TR in r.f. system
Z–101	Modulator Compartment	lower center

TEST POINT LOCATIONS

Accessory Control Unit

All locations are described looking at the top side with front panel toward operator. This system is maintained for underside locations.

C–701	Right front beneath chassis
C–702	Front top of right sub-panel beneath chassis
C–704	Center of center sub-panel beneath chassis
C–706	Center of center sub-panel beneath chassis
C–707	Center of right sub-panel beneath chassis
C–708	Top rear of right sub-panel beneath chassis
C–710	Rear of center sub-panel beneath chassis
E–701	Right rear beneath chassis
J–701	Junction box at rear of unit
K–701	Right side above chassis
R–701	8000 YD SET: LOW Control, front panel, lower left
R–704	40,000 YD SET: LOW Control, front panel, lower right
R–705	Front of center sub-panel beneath chassis
R–706	8000 YD SET: HIGH Control, front panel, lower left
R–707	40,000 YD SET: HIGH Control, front panel, lower right
R–710—R–715	Rear of center sub-panel, beneath chassis
R–716	Range potentiometer, front panel, lower center
R–718	Right front beneath chassis
R–728	Center of right sub-panel beneath chassis
R–730	Center of center sub-panel beneath chassis
R–731	Center of center sub-panel beneath chassis
R–739	Center of right sub-panel beneath chassis
R–740	Rear of right sub-panel beneath chassis
R–741	Rear of right sub-panel beneath chassis
R–743	MARK Control, front panel, lower right
R–775	Center of center sub-panel beneath chassis
R–776	Front of center sub-panel beneath chassis
R–777	Front of center sub-panel beneath chassis
V–701	Right front of chassis
V–702	Right center of chassis
V–703	Right rear of chassis


V-154 volts
V-280 volts
V-10 volts +
3 volts -
V-87 volts
V-35 volts
V-61.6 volts
V-92 volts +
23 volts -
V-5 volts +
2.5 volts -
V-1.5 volts
SQUARE WAVE
AMP. & LIMITER
CHANCE GATE
MULTIVIBRATOR
DIFFERENTIATOR
& TAIL CLIPPER
SHARPENER &
AMPLITUDE
CONTROL
FROM
SQUARE WAVE
MULTIVIBRATOR
IN INDICATOR
J-701
H
C-701
V-701A
6SN7GT
C-702
V-702A
6SN7GT
C-704
C-706
V-702B
6SN7GT
C-707
V-703A
6SN7GT
C-708
V-703B
6SN7GT
E-701
D
E
F
NEGATIVE
OUTPUT
POSITIVE
C-710
J-701
DJ
R-728
R-729
V-154 volts
R-740
R-741
R-743
MARKER
AMPLITUDE
TO REGULATED
HIGH VOLTAGE
R-710
to
R-715
K-701A
RANGE
RANGE
MAX.
SET
R-706
R-707
R-716
RANGE RING
CONTROL
R-731
R-730
K-701C
RANGE
V-17.5 volts
V-3 volts -
1 volt +
V-29 volts
V-701B
6SN7GT
STABILIZING
DIODE
R-775
R-776
R-777
R-705
R-701
RANGE
ZERO
R-704
K-701B
RANGE
V-3.5 volts

LEGEND :

1. Wave shapes are as seen on RCA 3" oscilloscope Arrows indicate points at which oscilloscope was connected.
2. All wave shapes taken with "Range" selector on 20 miles, and sweep frequency at 200 cps. Peak voltage is shown at each wave shape.
3. Time spacing on all wave shapes is 2,500 μsec. between similar parts of wave.
4. Letters and numbers outside tube blocks indicate tube elements and socket pins.
5. Heavy lines indicate main circuits.
6. Light lines indicate auxiliary circuits or controls.

Fig. 14. Servicing Block Diagram: Accessory Control Unit.

FUSE LOCATIONS

Model SO-1 Radar Equipment

Fuse	*Value (Amperes)*	*Function*	*Location*
F-104	1	Motor-Alternator: on speed regulator panel	Primary of T-104 in voltage regulator
F-105	3	Motor-Alternator: on speed regulator panel	Interlock circuit
F-106	15	Motor-Alternator: on speed regulator panel	Antenna motor field and heater circuit
F-201	1	Rectifier Power Unit: fuse panel	Filaments in Transmitter-Receiver
F-202	1	Rectifier Power Unit: fuse panel	Blower motor in Transmitter-Receiver
F-203	2	Rectifier Power Unit: fuse panel	Plate and filaments in Rectifier Power Unit
F-204	1	Rectifier Power Unit: fuse panel	Waveguide shutter and relay K-401
F-206	5	Rectifier Power Unit: fuse panel	T-105 primary circuit
F-401	1	Indicator: second fuse on left side	Primary of high-voltage transformer T-403 in Indicator
F-402	5	Indicator: first fuse on left side	D.C. control circuits
F-403	6	Indicator: third fuse on left side	Synchros
F-404	2	Indicator: fourth fuse on left side	Indicator power supply
F-701	2	Accessory Control Unit: right front above chassis	T-701, T-702, and a.c. line voltmeter
F-702	1	Accessory Control Unit: center left above chassis	Automatic frequency control
Spares		Accessory Control Unit: right front above chassis near panel	
F-1201	3	IFF Control Unit	External IFF equipment

LOCATING FAULTY UNITS

If normal operation cannot be restored by the quick check-up already outlined, the trouble is probably due to failure of one or more components within a unit.

Assuming that all fuses have been checked, the search for the source of failure should start with close observation of the control panel and PPI screen on the Indicator. After the trouble is isolated to a single unit, it should be further isolated to components by making voltage and resistance checks.

When the equipment is operating normally, the PPI is easily read and interpreted. The trace sweeps evenly around the PPI screen. A moderate amount of "snow" is evenly distributed over the screen surface. The markers describe perfect circles, and the targets are sharp and clear. The bearing dial lights respond to the adjustment of PILOT Control L.

On the other hand, faulty operation of the equipment will almost invariably show up in abnormal appearance of the PPI screen or abnormal functioning of the operating controls, and these symptoms will point to the faulty unit.

Motor-Alternator Check

Failure of the pilot lights and absence of the PPI trace indicate loss of power to the equipment, which points to a faulty Motor-Alternator. First check PILOT Control L by turning it up to maximum. If the pilot lights are still completely out, the Motor-Alternator may be dead. If the pilot lights come up but no trace appears on the PPI, the Motor-Alternator-Modulator is functioning, although perhaps not perfectly.

An intermittent PPI trace is usually caused by uneven firing of the rotary spark gap on the Alternator. (Another possible cause is incorrect adjustment of the multivibrator bias control R-429.) The CRP-10212 spark gap may be temporarily adjusted (but not the CRP-10249 "basic" gap) by following the procedure given on page 45.

Modulator Check

If the pilot lights are on but no trace at all is obtained, set N-E Switch E to the "E" (Emergency) position while holding the START Button in. (The protective relay may have opened because of a temperature rise in the Transmitter-Receiver.) If no trace is obtained on the PPI even at the emergency position, the Modulator may be defective.

Transmitter Check

If the trace and markers appear on the PPI, but no signals, the trouble may be either in the Transmitter-Receiver or Indicator. In this event, the Transmitter should first be checked to see if it is operating normally. There are two ways of doing this:

(a) Switch on the Echo Box. If the Transmitter is functioning normally and the Echo Box is properly tuned, the neon bulb will glow.

(b) Turn back the rubber boot over the waveguide coupler and insert a small screwdriver between the waveguide flange and the coupler. If the Transmitter is working, a 400-cycle arcing tone will be heard. This is a more positive check than the neon bulb test.

Receiver and Rectifier Power Unit Check

If the Transmitter is found to be operating normally, the Receiver may be at fault. Before assuming this, however, examine the Rectifier Power Unit, which supplies power to the Receiver. Make sure that all tubes are lighted by looking through the louvers. (The Rectifier Power Unit is not likely to fail. Except for replacement of tubes and fuses, this unit ordinarily requires no maintenance.)

The Receiver is difficult to check without instruments. If "grass" is obtained when GAIN Control C is far advanced, the i.f. stages are probably functioning normally, although the crystal mixer cartridge may be defective. If no grass is seen, the trouble may be either in the Receiver or in the Indicator.

Indicator Check

If no signals appear on the PPI after checking the Motor-Alternator-Modulator, Transmitter-Receiver, and the Rectifier Power Unit, the fault probably lies in the Indicator. This unit is difficult to test aboard ship, but it is the easiest of all units to replace if a spare Indicator is available.

LOCATING FAULTY COMPONENTS

The following information is given for the guidance of experienced personnel at SO bases when servicing faulty units returned for exchange.

It is assumed that the trouble has already been traced to a particular unit. The faulty component can now be found in several ways, the most convenient being through voltage and resistance measurements.

The Table of Voltage Measurements lists the socket voltages at all tubes. Measurements should be made on the faulty unit and compared with the values given so as to isolate the trouble. Since some of the tube potentials are affected by the adjustment of controls, measurements should be made with controls set as specified in the table. In addition, the resistance of suspected parts may be taken and compared with values shown on schematics. (See page 24 for values of controls.)

The Indicator and Accessory Control Unit are so constructed that inter-unit cables are automatically disconnected when the chassis is withdrawn from the case. To permit checking these units under operating conditions, a special test cable is included in ship's spares. This is used to connect the chassis of the Indicator or A.C.U., after removal, to the cable terminals in the case.

Two Servicing Block Diagrams and two Tables of Test Point Locations are also provided in this section, one diagram and table covering the main units of the equipment and the other diagram and table covering the A.C.U.

MISCELLANEOUS SYMPTOMS OF FAILURE

Interference with Ship's Communications Equipment

(a) Inadequate bonding to the ship's ground system (see page 15).

(b) Internal breakdown in pulse cable.

(c) Bad contact between magnetron anode lead and ball tip.

(d) Arcing between magnetron tip and adjacent waveguide surface. Check for scale in waveguide, mechanical misalignment of r.f. system, and water in the waveguide.

Weak Reception of Echoes

(a) Local oscillator, crystal mixer, or TR box improperly tuned (see page 57).

(b) Defective duplexing tube or local oscillator tube; dirty tube fins; loose tube cavities.

(c) Defective crystal cartridge in mixer.

Irregular Markers and Fuzzy Signals

This trouble is usually caused by a defective voltage regulator or spark gap. To determine which is at fault, proceed as follows:

(a) With the equipment off, remove the indicator chassis and connect between P-401 and J-401 the indicator test cable found in ship's spares.

(b) Turn on the equipment, *but do not start the Modulator. Advance the MARKS Control.*

(c) Adjust multivibrator bias control R-429 (located behind the indicator panel) until markers appear on the screen. Start the Antenna rotating and note the markers.

If the spark gap is causing the wavy markers, the markers will now appear as perfect concentric circles; but if the voltage regulator is causing the trouble, the wavy markers will remain.

(d) After completing the test, set the Range Switch to 80 and adjust R-429 until the markers disappear, continuing to rotate R-429 slightly beyond this point in the same direction. Turn the Range Switch back and forth several times, and if markers reappear, readjust R-429 until they disappear.

(e) Shut off the equipment, remove the test cable, and replace the Indicator in its case.

Procedures for repairing and adjusting both types of spark gaps and the voltage regulator are given on pages 45, 47, and 50. Be sure to use the correct procedure.

4.3 MAINTENANCE INSTRUCTIONS

Arranged by Units

In the mechanical design of SO-Series Radar Equipment every effort has been made to provide maximum accessibility consistent with good electrical design. To facilitate maintenance and replacement, units are regularly provided with removable covers. The Indicator and A.C.U. use instead a special drawer-like arrangement which permits the chassis to slide in and out of its case. Connections to these two units are made by means of a jack board and plug board (see end of Sec. 10).

Procedures for replacing units are given under the various unit headings.

Motor-Alternator

GENERAL

The Motor-Alternator was carefully tested and properly adjusted before leaving the factory. Brushes and contacts should be cleaned regularly, *but no other adjustments should be made without first determining that they are necessary*.

The SO-1 Radar may use either a Leland or a Murray (Imperial) Motor-Alternator. The two types are electrically equivalent and mechanically almost identical. The servicing procedures outlined below will apply to both types unless otherwise indicated.

Two types of spark gaps are now in use. The original type CRP-10212 will eventually be replaced by the later type "basic gap" CRP-10249 when all the original gaps and spares have been worn out. Because the adjustment and maintenance procedures for the two gaps are widely different, two separate procedures will be given. *Be sure to use the right procedure.*

BEARINGS AND ELECTRICAL CONTACTS

(Leland and Murray)

Ball bearings are used throughout the Motor-Alternator Assembly. These bearings should be lubricated during the installation of the equipment and at regular intervals thereafter. Both the Motor and the Alternator are equipped with two grease cups each. These should be refilled quarterly with Andok grade C grease and screwed down progressively between fillings. (Cans of this grease are included in spares for this purpose.)

NOTE: On the Murray (Imperial) Motor, one grease cup is covered by the speed regulator housing. This housing must be removed when refilling the grease cup.

The spark gap (both types) employs sealed ball bearings and requires no attention for at least one year. During the annual overhauling of the Motor-Alternator, the gap should be dismantled, cleaned, and inspected. Usually the gap ball bearings will require replacement at this time.

Four brushes are used on the commutator of the Motor. In addition, two small brushes are included in the speed regulator switch assembly mounted on the free end of the Motor. Four slip rings, with a single brush on each ring, are used on the Alternator.

NOTE: Early-type Murray Alternators used two brushes on each slip ring — eight brushes in all. To reduce temperature rise in these Alternators, one brush should be removed from each slip ring (four in all) and discarded. (See SO Bulletin #35 — Navy Modification #26.)

The exciter, which is an integral part of the Alternator, employs two brushes on its commutator.

The spark gap (both types) employs two brushes on a single slip ring.

Commutators and slip rings should be inspected regularly, and polished with a clean dry cloth or piece of canvas. If this treatment proves inadequate for polishing, a piece of fine sandpaper or crocus cloth may be used. *Never use emery cloth or emery paper on commutators or slip rings.* If, however, the polishing cannot be properly done in place, the unit may be disassembled, and the commutator or slip rings may be turned down and polished on a lathe by a competent machinist.

EARLY-TYPE SPARK GAP (CRP-10212)

Water Trap

The water trap attached to the spark gap exhaust manifold should be emptied once a week. If this is not done, water may overflow into the spark gap and prevent firing. Be careful in disposing of this water, since it may contain nitric acid formed by water combining with exhaust gases from the gap.

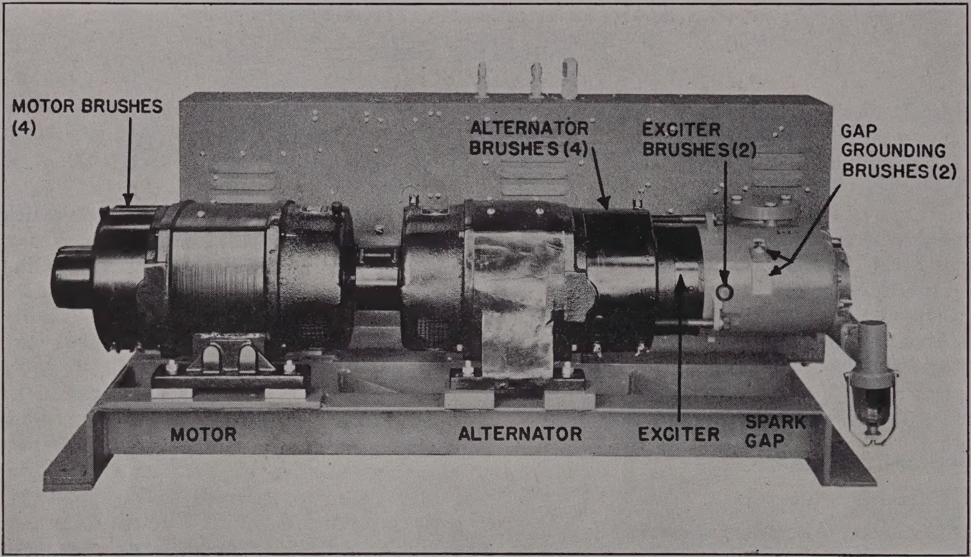

MOTOR BRUSHES (4)
ALTERNATOR BRUSHES (4)
EXCITER BRUSHES (2)
GAP GROUNDING BRUSHES (2)
MOTOR
ALTERNATOR
EXCITER
SPARK GAP

Fig. 15 — Motor-Alternator-Modulator with CRP-10212 Spark Gap.

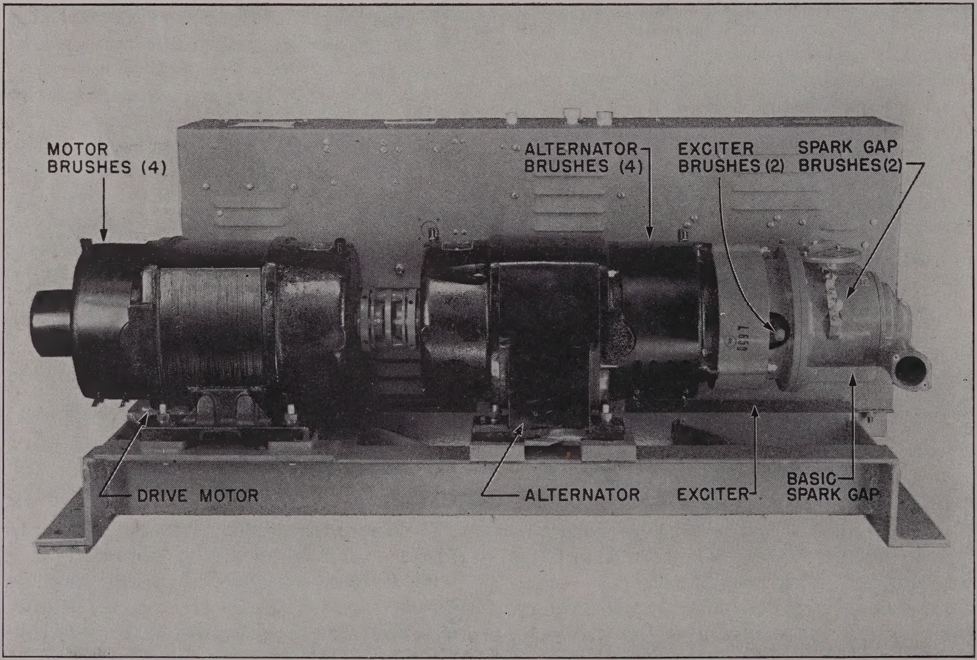

MOTOR BRUSHES (4)
ALTERNATOR BRUSHES (4)
EXCITER BRUSHES (2)
SPARK GAP BRUSHES (2)
DRIVE MOTOR
ALTERNATOR
EXCITER
BASIC SPARK GAP

Fig. 16 — Motor-Alternator-Modulator with CRP-10249 Spark Gap.

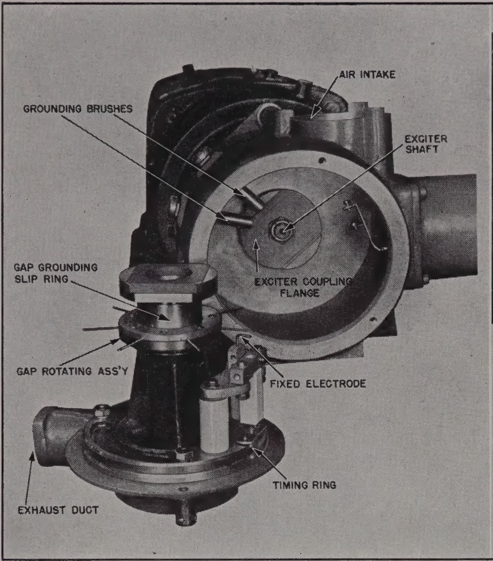


Fig. 17 — Motor-Alternator-Modulator: CRP-10212 spark gap details.

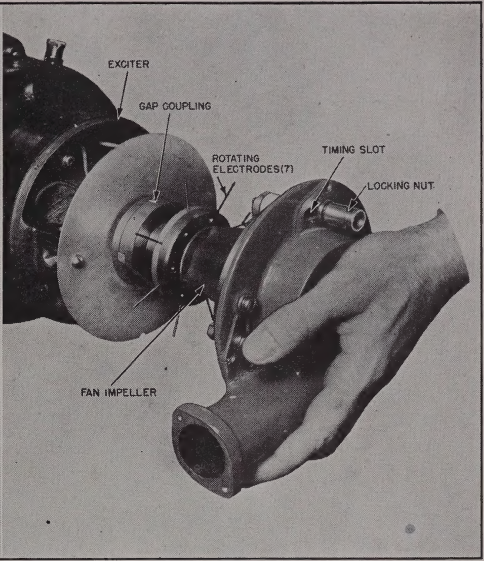


Fig. 18 — Motor-Alternator-Modulator: CRP-10212 spark gap skeleton.

Replacement

The SO-1 Modulator employs half-wave d.c. charging of the pulse line with a slow-speed spark gap. This combination provides a reliable modulation system with minimum maintenance.

A complete spark gap is included in equipment spares. When the gap in use is no longer serviceable, the easiest remedy is to replace the old assembly as follows:

(a) Remove the air filter cap on the gap (see Fig. 19). Working through this opening, remove the gap connection by taking out the #6 fillister-head screw and slipping off the special lug.

(b) Disconnect the exhaust hose and water trap at the manifold (see Fig. 15).

(c) Make a mark on the exciter-generator half of the coupling flange opposite a rotating electrode. This will insure correct timing (phasing) during reassembly.

(d) Remove the two gap grounding brushes. Remove the three outermost ¼″ screws on the gap end and carefully remove the gap electrode assembly (see Fig. 17).

(e) Carefully install the new gap assembly, reversing the above procedure, and meshing the coupling so that a rotating electrode is opposite the mark on the exciter flange. Before starting, make sure that some clearance exists between the gap coupling flange and block.

NOTE: Three types of gap couplers are now in the field. The original type employed a spline and gear arrangement. Equipments using this type of coupling (Model SO-1 Equipments #1—#15 only) also had an obsolete type of Motor-Alternator-Modulator which is being replaced in the field. The second and third types of gap couplers are similar in that they both use a phenolite block as the coupler. However, THESE TWO TYPES ARE NOT DIRECTLY INTERCHANGEABLE, *owing to a slight difference in size. When replacing the entire gap assembly, the same type of assembly must be substituted, unless the coupling flange on the exciter is also changed.*

A new-type universal coupling half (Stores #4010-L273) is available to fit both the second and third types.

A new-type universal gap (basic gap) is now being shipped for replacement purposes. Suitable adapters will be shipped with the replacement gap so that it will fit any SO-1 Alternator now in use.

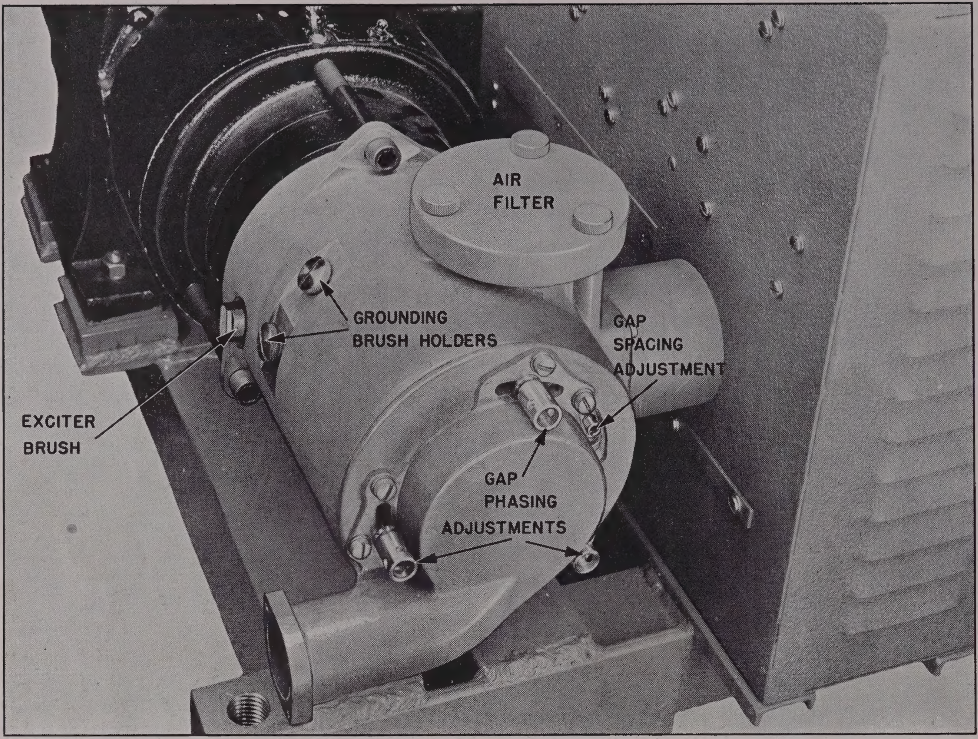


Fig. 19 — Motor-Alternator-Modulator: crp-10212 spark gap assembly.

Individual Electrode Replacement

Individual rotating electrodes or the fixed electrode may be replaced in the disassembled gap electrode assembly. The procedure follows:

(a) Loosen the countersunk clamping screws in the rotating flange with an offset screwdriver, and pull out the defective electrodes (see Fig. 17).

(b) Secure new electrodes from ship's spares and install in the flange grooves. (The electrodes must project exactly 1″ above the flange.) Tighten the clamping screws evenly.

(c) If the L-shaped fixed electrode is damaged, loosen the two Allen setscrews clamping the electrode and remove the latter.

(d) Secure a new electrode from ship's spares and install in the holder. Partially tighten the clamp until the electrode is so positioned that it just misses the rotating electrodes when the rotor is turned. The fixed electrode should be slightly longer (about $\frac{1}{32}$″) than the rotating electrodes for best gap operation.

(e) Turn the fixed electrode in its mount until it makes an angle of 11° with a rotating electrode when the latter is in firing position. With the gap rotating in its normal direction (clockwise facing the gap end), the tip should be the first part of the fixed electrode to meet the rotating electrodes.

(f) Adjust the gap spacing screw (see Fig. 19) until the fixed electrode just touches a rotating electrode when the rotor is turned (see Fig. 17). Now turn the rotor to determine whether all rotating electrodes are in the same plane; i.e., just barely touching the fixed electrode. If any are not in line, very cautiously bend the misaligned electrode with a slow pressure until it is properly aligned. It may be necessary to slightly loosen the two spacing lock screws to make spacing adjustments. These screws are located on each side of the spacing adjustment.

NOTE: The electrodes are made of tungsten and are extremely brittle. They can only be bent a very small amount, and bending must be done with a slow even pressure.

(g) Adjust the gap spacing to 0.015″. In the absence of a suitable gauge this may be done by adjusting the spacing until the electrodes just touch and then opening the spacing by rotating the electrode spacing adjustment screw (see Fig. 18) clockwise one-half turn. Lock the spacing adjustment.

WARNING: Never attempt to adjust the gap spacing while the Motor-Alternator is running. After adjustment *always* rotate the assembly *by hand* to determine whether or not any of the electrodes touch.

(h) Carefully replace the gap assembly in its housing.

Spark Gap Timing

Owing to the use of d.c. charging of the pulse line, spark gap timing is not critical. It is possible, however, for the locked gap to get out of step if the gap coupling is meshed improperly when replaced. To prevent misalignment, a scribed mark should always be made on the exciter flange opposite a rotating electrode before disassembly, or a permanent filemark may be made on the flange. The mark should be aligned with a rotating electrode when reassembling. The gap may be adjusted over more than 200 *electrical degrees*. For proper operation the gap must fire during the period when the charging diode is non-conducting, and it is not critical through this sector of 180 electrical degrees. If the gap is adjusted to fire during the wrong half-cycle, the charging diode will be short-circuited and the charging current will rise.

NOTE: If the gap is timed to fire on the wrong half-cycle the firing will be somewhat ragged, rectifier V-104 will overheat, range markers may be wavy, fuse F-206 will blow, and charging transformer T-105 will overheat. Obviously, operation with improper timing will damage the equipment and should be avoided.

Owing to the nature of the gap, proper gap timing cannot be determined from the firing sound. Optimum setting is done with the aid of a 0–5 400–cycle a.c. ammeter as follows:

(a) Remove the cover from the modulator compartment and connect the a.c. ammeter to the interlock. (An ordinary household outlet plug, slightly opened, fits the interlock and makes a convenient connector.)

(b) Start the equipment as usual. Start the Modulator and note the current. If F–206 should blow during this step, loosen the timing adjustment (see Fig. 19) and slide the timing ring to the *distant* end of the slot. Should the fuse blow with this adjustment, try the other end of the slot.

(c) The current should be between 2.3 and 2.6 amperes and should be constant over at least half the timing slot. To determine the bounds of the constant-current region, slowly move the timing adjustment both ways until the current begins to rise.

NOTE: If the constant-current region is less than half the timing slot, remove the gap electrode assembly, turn the gap rotor 180° (see Fig. 17) and reassemble. (If a permanent mark was made on the exciter coupling flange, this mark must also be shifted 180°.) Now repeat steps (b) and (c) above.

(d) Lock the timing adjustment in the center of the constant-current region. This adjustment is permanent unless the gap electrode assembly is removed. Lace wire through the holes in the timing adjustment screws and seal with a lead seal.

BASIC SPARK GAP (CRP-10249)

Water Trap

The water trap attached to the spark gap exhaust manifold should be emptied once a week. If this is not done, water may overflow into the spark gap and prevent firing. Be careful in disposing of this water, since it may contain nitric acid formed by water combining with exhaust gases from the gap.

Repair of Spark Gap

To replace the rotating electrodes, the gap must be removed from the Alternator. The disassembly procedure follows:

(a) Remove the air intake cover and loosen the 6/32 fillister-head screw clamping the connection running from the gap feed-through bushing (see Fig. 20).

(b) Remove the modulator cover and disconnect the Thyrite lead at the feed-through bushing. Remove the four screws in the

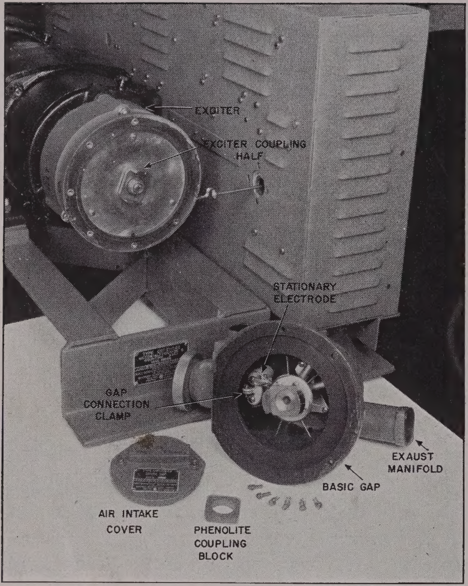


Fig. 20 — Basic Spark Gap.

flange around the feed-through bushing and lift out the bushing (see Fig. 20).

(c) Looking through the air intake opening, determine whether or not there is a punch mark, file mark, or paint dot in the center of one of the curved edges of the alternator coupling half in line with one rotating electrode (see Fig. 23). If none is found, temporarily mark the curved edge of the alternator coupling half whose center is exactly in line with one rotating electrode. (Only one of the edges is so aligned.)

(d) Disconnect the exhaust system by removing the two screws securing the water trap assembly to the gap exhaust manifold.

(e) Remove the six 10/32 screws securing the gap to the Alternator and carefully lift off the gap.

(f) Remove the phenolite coupling block (see Fig. 20). If no timing mark was found on the alternator coupling half, mark the half with a prick punch, using the temporary marking as a guide. Make a second mark on the alternator shaft in line with the first mark (see Fig. 23).

(g) Lay the gap on its exhaust end and remove the screw (within the hollow shaft) securing the coupling half (see Fig. 22). Remove the coupling half by pulling straight outward (see Fig. 21).

(h) Remove the rotating electrodes by taking out the four clamping screws. Lift off the separator ring and the rotating electrode ring (see Fig. 21).

(i) If the stationary electrode is broken or burned, remove it by loosening the two clamping screws and lifting out the electrode (see Figs. 20 and 22).

NOTE: The stationary electrode can be replaced and adjusted through the air intake opening without disassembling the gap.

(j) Secure new rotating and stationary electrodes from spares. Insert the new stationary electrode in the holder and partially tighten the clamping screws.

(k) Remove and examine the gap grounding brushes, and replace if worn (see Fig. 21). Examine the slip ring and if badly worn or scored, replace the gap.

(l) Install the new rotating electrode ring so that the side with the rounded inner edge is against the flange (see Fig. 21). Align the four holes, replace the separator ring, and secure with the four screws. Replace the gap coupling half.

(m) Move the stationary electrode forward until it just touches the rotating electrodes, then rotate the electrodes by hand to determine if any are out of line. If so, bend the misaligned electrodes into line *with a slow even pressure.*

(n) Adjust the electrode spacing for 0.009″ with the gauge found in the spare brush box mounted on the air intake cover (see Fig. 22). Turn the stationary electrode in its mount until it makes an 11° angle with the rotating electrodes (see Fig. 22). This angle is such that the electrode tips are the first parts to meet in normal rotation, and firing takes place from these tips. (Some of the spacing gauges have an 11° notch for this adjustment.) Tighten the stationary electrode clamping screws.

(o) Insert the phenolite coupling block in the gap coupling half. Replace the gap assembly, meshing the coupling so that one

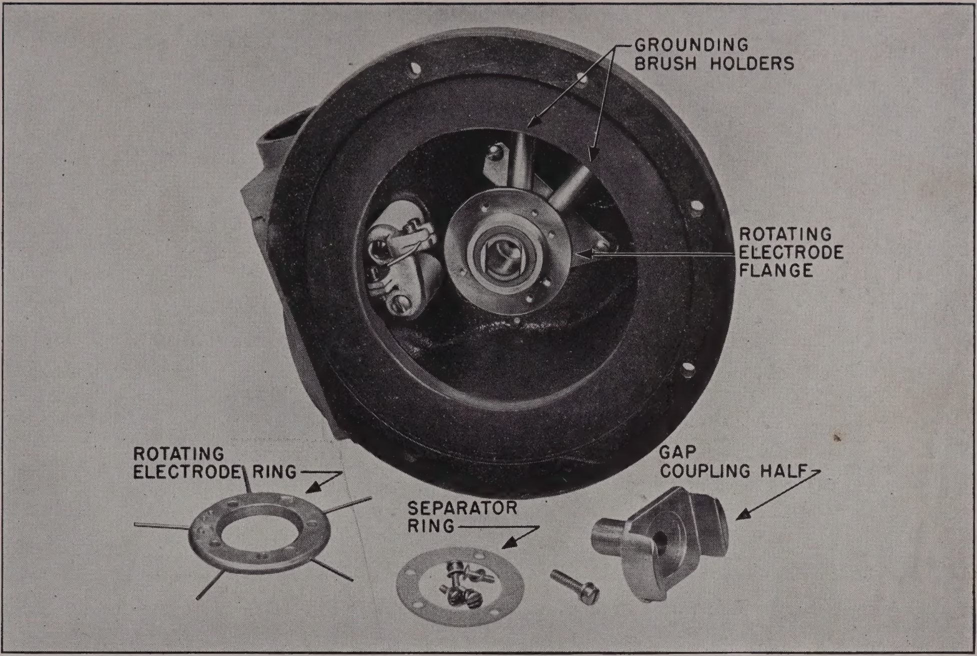

GROUNDING BRUSH HOLDERS
ROTATING ELECTRODE FLANGE
ROTATING ELECTRODE RING
GAP COUPLING HALF
SEPARATOR RING

Fig. 21 — Basic Spark Gap (so-1 uses seven-electrode ring).

rotating electrode is exactly in line with the punch mark on the curved edge of the alternator coupling half (see Fig. 23). Secure the gap by replacing the six screws around the gap flange.

(p) Replace and secure the gap feed-through bushing in the Modulator, making sure that the gap lead is seated between the clamp jaws (see Fig. 20). Replace the Thyrite lead and tighten the gap lead clamping screw inside the gap.

(q) Replace the air intake cover and water trap assembly.

Adjustment of Gap Timing (Phasing)

All basic gaps and Alternators will have standard timing marks made at the factory (see Fig. 23). In every case, one of the rotating electrodes will bisect one rounded edge of the alternator coupling half, and the point of bisection will be marked by a punch mark, file mark, or dot of paint. In line with this mark, a second mark will be found on the alternator shaft. When the alternator coupling half is removed or the Alternator is replaced, the coupling half must be reinstalled so that the timing mark on the shaft is in line with the mark on the edge of the coupling. Then, when the gap is replaced, a rotating electrode must be aligned with the mark to establish timing.

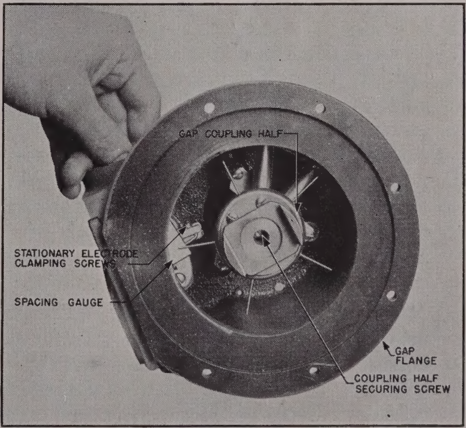

GAP COUPLING HALF
STATIONARY ELECTRODE CLAMPING SCREWS
SPACING GAUGE
GAP FLANGE
COUPLING HALF SECURING SCREW

Fig. 22 — Basic Spark Gap: spacing adjustment.

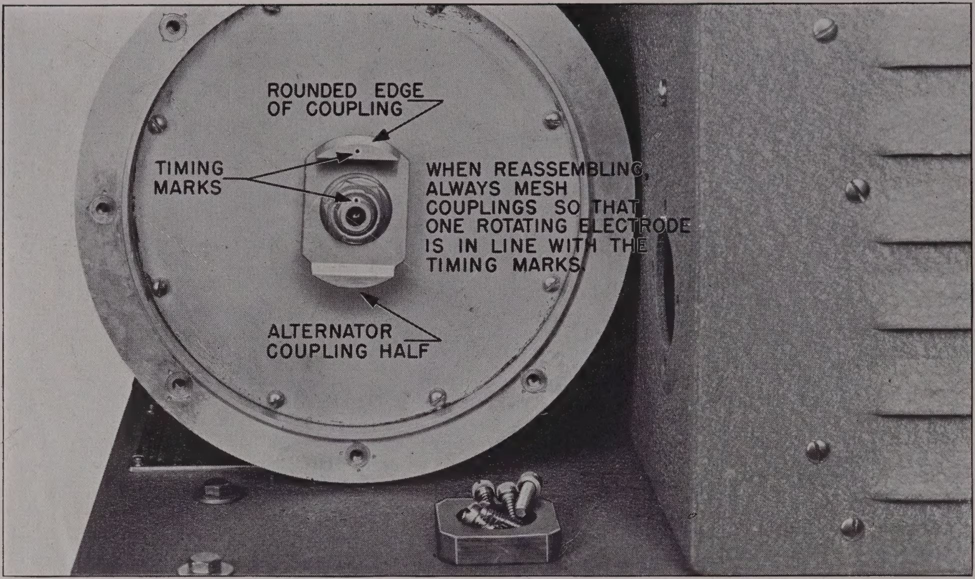

ROUNDED EDGE OF COUPLING
TIMING MARKS
WHEN REASSEMBLING, ALWAYS MESH COUPLINGS SO THAT ONE ROTATING ELECTRODE IS IN LINE WITH THE TIMING MARKS.
ALTERNATOR COUPLING HALF

Fig. 23 — Basic Spark Gap: typical timing marks (shown on SO-13 motor-alternator-modulator).

If for any reason the timing marks are missing or have been removed, proper timing must be restored with the aid of an oscilloscope. The procedure follows:

(a) On SO-1 Modulators, connect the vertical plates of an oscilloscope between the ungrounded end of R-161 (in the Modulator) and ground. *Make certain that these connections are on the low-potential end of the divider.* Connect a 0–5 400-cycle a.c. ammeter to modulator interlock S-101. Start the equipment.

(b) Turn on the Modulator and note the ammeter reading. If the current is less than 3 amps., proceed to step (c). If, however, the current exceeds 3 amps., shut off the equipment, remove the gap from the Alternator, turn the gap coupling 180° *without changing the position of the alternator coupling*, and reassemble. Then start the equipment again and turn on the Modulator. The current should now be less than 3 amps.

(c) Adjust the horizontal sweep of the scope until seven or more pulse-line waveforms appear on the screen. (Fig. 24 shows these waveforms with the plate voltage of charging diode V-104 superimposed and appearing as a dotted sine wave.)

For optimum gap timing, the gap should fire at the exact instant when the plate voltage of the charging diode V-104 is at its maximum *negative* value. On the oscilloscope, optimum timing is indicated when the end of the pattern (gap breakdown point) is exactly three-quarters of the distance between the points where the patterns begin to rise. In Fig 24, the gap break-

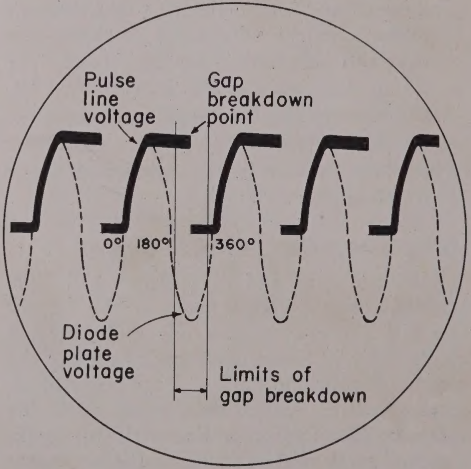

Pulse line voltage
Gap breakdown point
0°
180°
360°
Diode plate voltage
Limits of gap breakdown

Fig. 24 — Normal Oscilloscope Waveforms.

down should occur at exactly 270°, but the gap will fire satisfactorily if breakdown occurs anywhere between 200° and 340° (i.e., within the range marked "limits of gap breakdown"). If breakdown does not occur within this range after completing step (b) above, proceed to step (d).

(d) Shut off the equipment and remove the gap from the Alternator. Remove the coupling half from the Alternator, and replace, using the alternative keyway. Reassemble the gap. Start the equipment and turn on the Modulator. The breakdown point should now fall within the limits or else be 180° removed. In the latter case, shut down the equipment, remove the gap, turn the coupling 180° as in step (b), and reassemble. Then restart the equipment and check the timing.

(e) When the timing is satisfactory (i.e., within the limits), shut down the equipment, and disconnect the meter and oscilloscope.

(f) Add timing marks as already outlined.

SPEED REGULATOR

The frequency of the Alternator is held between 400 and 425 cycles by means of a centrifugal-type speed regulator and associated equipment. If trouble is experienced with the speed regulator, switch S-107 should be inspected before any attempt is made to adjust the regulator. For proper operation, the contacts of S-107 should be clean and parallel. The commutator and brushes should be clean and smooth (see Fig. 25).

Speed regulator adjustments are difficult to make and should not be attempted in the field unless accurate instruments for measuring r.p.m. (or frequency) and line voltage are available. A method that may be successfully used in the field follows:

(a) With the Main Line Switch off, remove the cover over the regulator compartment of the Motor-Alternator-Modulator. Connect a frequency meter (300—500 c.p.s.) to terminals 1 and 2 on E-113. Connect a 0—150 volt d.c. voltmeter to terminals 101 and 102 on E-115.

(b) Arrange a short jumper wire on one terminal of C-104 (located above the voltage regulator panel) so that C-104 may be short-circuited when desired.

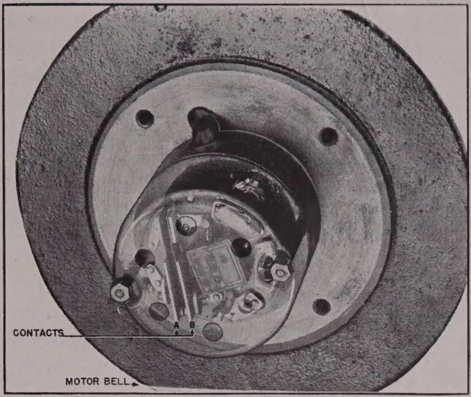


Fig. 25 — Speed Regulator.

(c) If the Motor-Alternator-Modulator is of the early type, set R-115 (located on the fuse and resistor panel) to its maximum resistance and lock. (In later Motor-Alternator-Modulators this resistance is fixed.)

(d) Start the Motor-Alternator and note the d.c. line voltage and frequency.

NOTE: During this procedure, the alternator load should consist of the basic Radar only, and not include additional loads such as true-bearing accessories, IFF equipment, Accessory Control Unit, etc.

(e) Short-circuit C-104 with the jumper and note the change in alternator frequency. Adjust R-114 until the frequency change is within the limits set by the line voltage as shown in the chart.

(f) If it is impossible to set the frequency change within the prescribed limits, shut down the equipment and remove the cover over the speed regulator switch which is located on the free end of the drive motor.

(g) If the frequency change was too large, loosen the contact B adjustment (see Fig. 25) so that the contact is nearer the shaft. Tighten the adjustment on contact B to maintain the contact spacing at 0.025″. If the frequency change was too great, adjust the contacts in the opposite direction.

(h) Start the equipment and repeat step (e).

(i) Continue to adjust the contacts as in step (g) and R-114 as in step (e) until the frequency change is within the prescribed limits and the alternator frequency, with C-104 not shorted, is between 400 and 425 cycles.

(j) Shut off the equipment, lock all controls, replace the speed regulator covers, disconnect the meters, and replace the regulator compartment cover.

FREQUENCY CHANGE WHEN C-104 (S-107) IS SHORTED:

Line Voltage	*Change*
90	85 to 100 c.p.s.
95	80 to 95 c.p.s.
100	68 to 83 c.p.s.
105	57 to 73 c.p.s.
110	47 to 62 c.p.s.
115	35 to 50 c.p.s.
120	23 to 37 c.p.s.
125	12 to 27 c.p.s.
130	0 to 15 c.p.s.

Modulator and Voltage Regulator

Removal of 705A Rectifier Tube

To remove this tube, pull off the plate cap, turn one base lock pin with a screwdriver until the locking lever clears the tube base. Release the second lock by moving the small lever with the thumb, then withdraw the tube.

Voltage Regulator

The voltage regulator is properly adjusted at the factory and will normally require no readjustment unless the controls have been tampered with or tubes of different characteristics are used. The field procedure is outlined below:

(a) With the equipment off, connect a 0–150 volt 400-cycle voltmeter to terminals 1 and 2 of E-113. Check the voltage of bias battery B-106. Replace if under 18 volts.

NOTE: The speed regulator must be properly adjusted or proper voltage regulator adjustments cannot be made.

(b) Remove the top cap on the V-103 thyratron and start the equipment. Do not start the Modulator.

(c) Adjust R-113, located on the fuse and resistor panel (see Fig. 26), until the a.c. output is approximately 105 volts. Replace the top cap.

NOTE: Under no conditions should the output voltage be less than 85 volts.

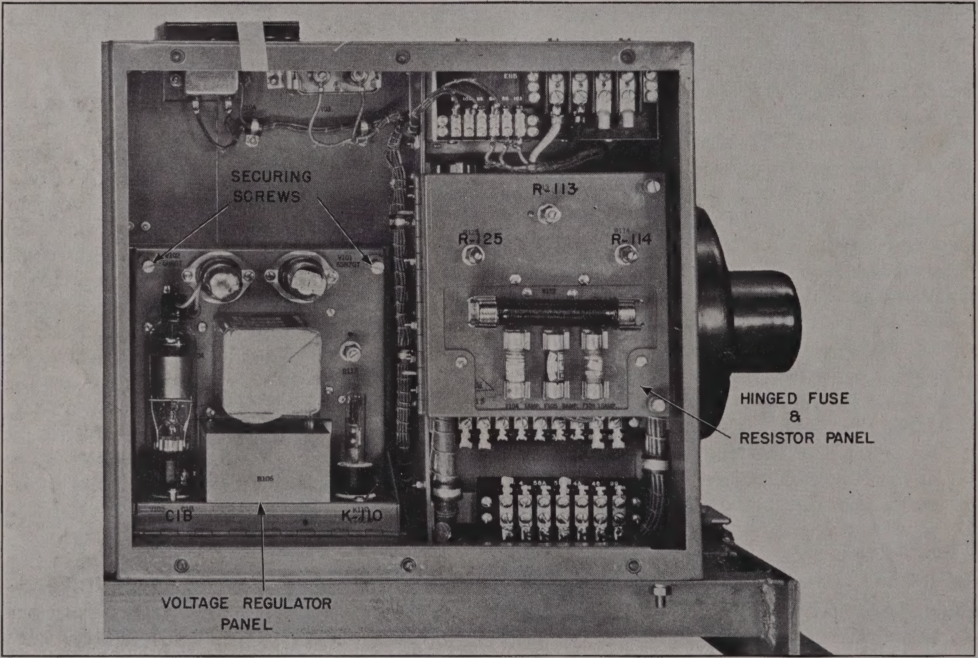


FIG. 26 — MOTOR-ALTERNATOR-MODULATOR: VOLTAGE AND SPEED REGULATOR ADJUSTMENTS.

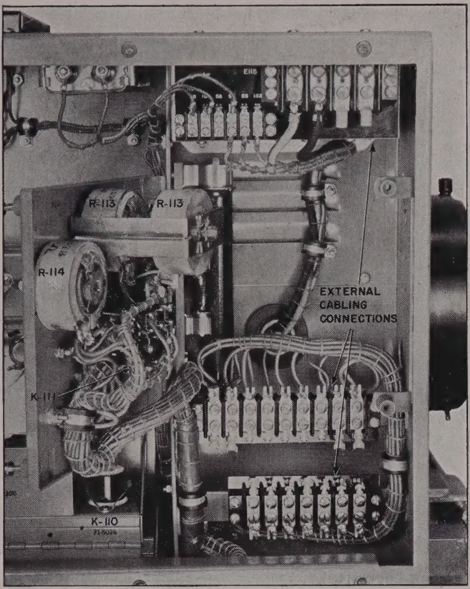


Fig. 27 — Motor-Alternator-Modulator: terminals.

(d) Adjust R-117, located on the regulator chassis (see Fig. 26), until the output voltage is 115 volts.

(e) Start the Modulator and note the a.c. voltage. If the change was more than 3 volts, readjust R-113 as in step (b) for a slightly lower value and then readjust R-117 as in step (d) for 115 volts. Repeat the adjustment of R-113 and R-117 until the regulation is within the prescribed limits.

(f) Place range markers on the PPI and observe whether or not flutter or oscillation of the regulator is present, as evidenced by uneven or wavy markers. If flutter is observed, adjust R-125 (located on the resistor panel) for an increase in resistance (clockwise). Readjust R-117 for 115 volts and check again for flutter. Continue to readjust R-125 in small steps, each time readjusting R-117 for 115 volts, until the flutter is eliminated.

NOTE: On early equipments using a fixed resistor in place of R-125, this adjustment cannot be made. Flutter may be eliminated in these equipments as outlined in step (g).

(g) If flutter is still present, it may be eliminated by adjusting R-113 for a lower value as in step (e).

NOTE: Should it be impossible to eliminate flutter by the above methods, there is possibly trouble in the regulator. Try replacing the tubes — first V-103, then the others.

Bias Battery

Proceed as follows to replace the bias battery (see Fig. 26):

(a) Remove the front cover from the regulator compartment.

(b) Loosen the two captive screws at the upper edge of the regulator chassis.

(c) Open the hinged chassis by pulling out and down on captive screws.

(d) Remove the red and black battery leads from terminal strip E-110, noting the connections (see Fig. 28).

(e) Close the hinged chassis and remove the four binder-head screws holding the battery case to the chassis.

(f) Lift out the battery and thoroughly clean the case, repainting if corroded.

(g) Check the new battery for proper voltage, and place it in the case with the leads located as on the old battery.

(h) Feed the battery leads through the holes in the chassis and screw the case to the chassis, using the four binder-head screws previously removed. *Be careful not to short-circuit the battery leads.*

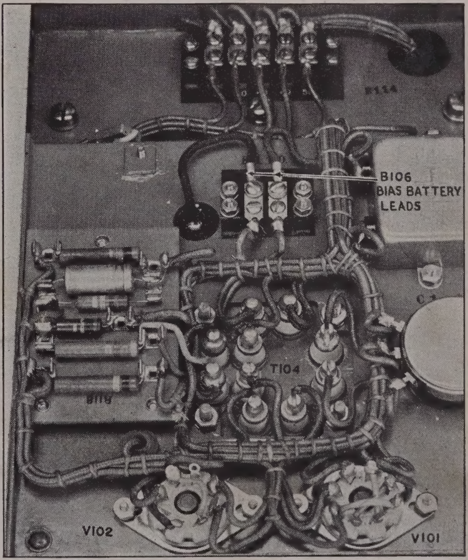


Fig. 28 — Motor-Alternator-Modulator: voltage regulator chassis open.

(i) Open the hinged chassis and connect the red and black leads to terminal strip E-110 (black lead to left terminal and red lead to right terminal).

(j) Close the hinged chassis and tighten the captive screws.

(k) Replace the front cover on the regulator compartment.

Magnetic Controller

ACCELERATING RELAY

Since the starting time of all SO-1 Motors is relatively constant, adjustments of the automatic starter may be made by adjusting the accelerating relay to close after a predetermined time. Should the closing time of the accelerating relay differ from the times given in the chart below, the relay should be adjusted as follows:

(a) If the closing time is too great, increase the air gap between the accelerating relay plunger and the lower (current) coil by running down the two large nuts on the plunger shaft above the upper (voltage) coil. If the closing time is too short, decrease the air gap by running the nuts upward (see Fig. 53).

(b) Measure the line voltage at the controller. Have someone start the Motor-Alternator and estimate or measure the time required for the relay to operate. Compare the time with the chart, and readjust as required, as outlined in step (a).

(c) Continue to start the machine and readjust the air gap until the starting time is correct according to the chart. *Be sure to lock the adjusting nut with the locking nut.*

VOLTS	TIME
95	2.3 secs.
100	2.1 "
105	1.9 "
110	1.75 "
115	1.6 "
120	1.4 "
125	1.25 "
130	1.00 "

OVERLOAD RELAY

The overload relay is set at the factory to open in a fraction of a second with a several hundred per cent. overload; however, during the course of a 10- or 15-hour run, sufficient heat may be stored in the relay so that it trips, thus shutting off the equipment. The relay has three positions: *–10% of normal*, *normal*, and +10% *of normal*. The *normal* position is marked by a silver dash adjacent to the adjusting lever, *–10% of normal* is marked by a red dot, and *+10% of normal* is marked by a silver dot. Should the overload relay open during extended periods of operation, it should be allowed to cool a few minutes and the adjusting lever set to the silver dot (*+10% of normal*) position. Unless trouble is encountered, the overload relay adjustment should be left on the *normal* (silver dash) position.

Transmitter-Receiver

Removal for Servicing

(a) Raise the rubber waveguide boot, loosen the mounting bolts, and slide the unit forward until the case clears the waveguide.

(b) Loosen all the wing captive screws under the unit and lift off the cover.

CAUTION: Avoid sharp bending of coaxial cables (see page 13).

NOTE: An optional method is to remove the short waveguide section above the Transmitter and then remove the unit cover. The waveguide must be replaced if test operation is desired.

Servicing the Unit While Operative

Operate the unit with the cover off and the test coupling choke installed as outlined on page 59 under "Tuning the R.F. System." The interlock must be bridged.

Removal for Replacement

The cabling should be disconnected by separating the jack board from the plug board, leaving the cable terminals intact. The procedure follows:

(a) Remove the cover from the smaller terminal box located beneath the unit and disconnect the inner conductor of the pulse cable.

(b) Remove the locknut from the terminal tube of the pulse cable and pull out the cable and tube.

(c) Loosen the captive screws holding the larger terminal box to the transmitter frame and remove the box complete with cables and jack.

(d) Remove the Transmitter Unit by loosening the mounting locks and waveguide boot, and slipping out the unit.

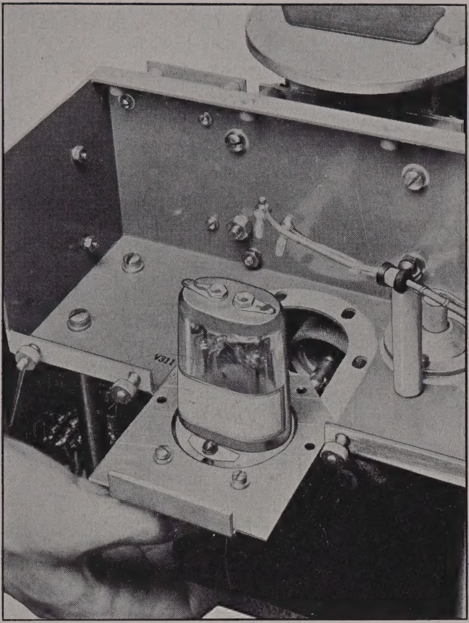


Fig. 29.

Removal of Receiver Strip

Remove the six leads on E-302, the mixer plug P-301, the video plug P-303, and the four mounting screws. Then lift out the strip.

Magnetron Oscillator

Removal

(a) Remove the sub-chassis cover above the magnetron.
(b) Remove the filament leads by pulling out the banana plugs.
(c) Loosen the large knurled ring nut clamping the magnetron to the waveguide coupling sleeve by reaching through the back side of the unit (beside the waveguide).
(d) Using a screwdriver, remove the four screws around the rear of the magnetron flange (see Fig. 29). When removing these screws reach under the magnetron and hold the threaded semicircular locking plate. Loosen the two front screws and carefully slide the magnetron outward until the anode tip clears the coupling sleeve. Detach the mounting plate spacer and small locking plate by removing the two loosened screws.
(e) Using the three new-type special tools provided in spares, remove the anode tip as follows:

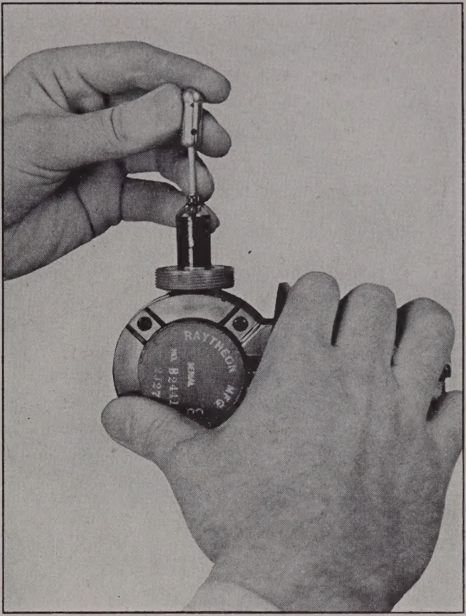


Fig. 30.

Hold the anode tip with the tip pliers, placing the two projecting pins in two of the holes in the base of the tip (see Fig. 33). Remove the ball tip with the spanner wrench (see Fig. 34). Loosen the inner clamp with the spanner key and slip off the lower section of the tip (see Fig. 33).

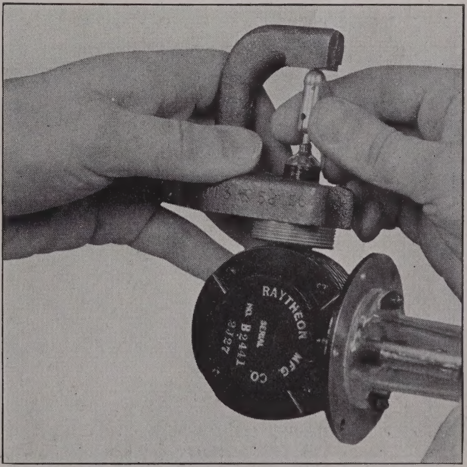


Fig. 31.

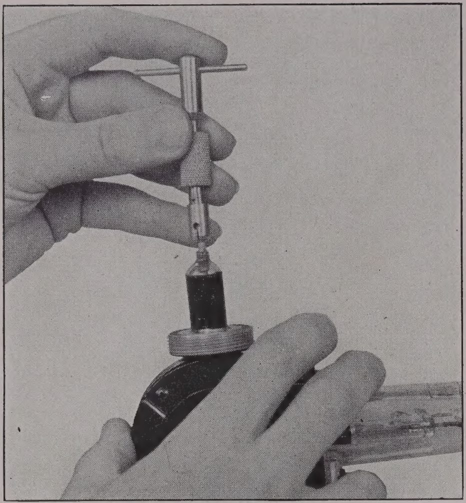


Fig. 32.

Installation

(a) Make sure that the anode lead of the magnetron and the tip to be installed are both clean.

(b) Slip the magnetron tip over the output lead of the magnetron (see Fig. 30).

(c) Seat the tip gauge on the magnetron (Fig. 31) and draw up the magnetron tip to within about 0.010″ of the gauge limit.

(d) Taking care to avoid changing the location of the tip on the output lead, unscrew the ball end of the magnetron tip and insert the spanner key (see Fig. 32). Screw the knurled portion of the tool down tight to avoid spreading the insert in the tip and damaging the tool.

(e) Hold the magnetron tip with the special pliers, making sure that the pins in the pliers seat in the holes in the tip. Raise the magnetron slightly off the bench, holding the spanner key, and turn the tip until the latter is tightly clamped to the magnetron (see Fig. 33).

(f) Still holding the magnetron tip with the special pliers, screw the ball end on the tip and tighten with the spanner wrench (see Fig. 34).

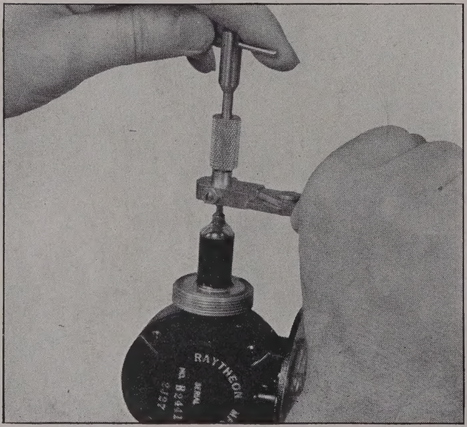


Fig. 33.

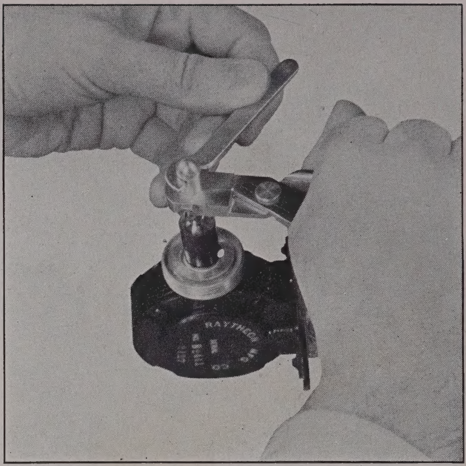


Fig. 34.

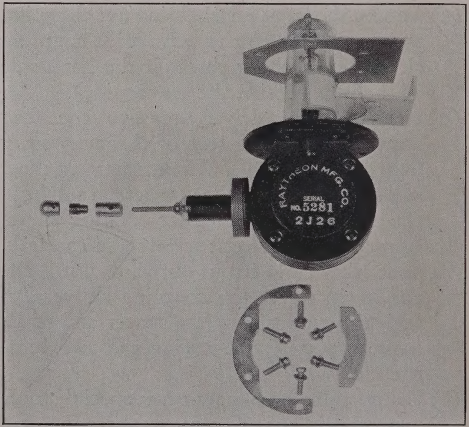


Fig. 35.

(g) Re-check the spacing of the tip with the tip gauge (see Fig. 31). The tip should be within ±0.005″ of the gauge.

NOTE: Be sure to use the tip gauge intended for magnetrons used on SO-Series Equipments. A different spacing is used on other equipments.

(h) Slip the mounting plate over the filament leads (see Fig. 35).

(i) Insert the spacer between the magnetron flange and the mounting plate, with the right-angle bend on top and opposite the anode lead (see Fig. 35).

(j) Place the smaller clamping ring over the tube flange and replace the two front clamping screws, leaving them loose.

(k) Carefully slide the magnetron into the Transmitter with the mounting plate above the chassis and the tube flange below (see Fig. 29).

(l) Place the larger clamping ring beneath the tube flange and loosely install the four clamping screws.

(m) Carefully tighten the large knurled clamping nut holding the tube to the waveguide coupling sleeve, making certain that the tube is centered in the magnet assembly.

(n) Tighten the six clamping screws and insert the filament leads.

(o) Replace the sub-chassis cover.

(p) Retune the r.f. system as outlined later in this subsection.

TR (Duplexing) Tube

After 300 hours of use, this tube should be replaced and the old tube discarded.

Removal

(a) Remove the keep-alive lead from the rear of the cavity. Remove the mixer.

(b) Unscrew the front and rear clamping rings.

(c) Carefully pull the cavity halves apart and remove the tube by pulling it out of the fixed half.

Installation

(a) Cautiously clean the fins of the new tube with a soft rubber eraser, then wipe them with a soft cloth moistened with carbon tetrachloride to remove any film of oil. Finally wipe them with a clean dry cloth. Take care to avoid injuring the thin plating on the fins.

(b) Carefully slide the tube into the fixed half of the cavity with the cap end toward the magnetron. Be careful not to bend the delicate fins on the tube, and make sure that these fins are outside the cavity lips.

(c) Carefully place the removable half of the cavity in position, making sure that the pins enter the holes in the fixed half.

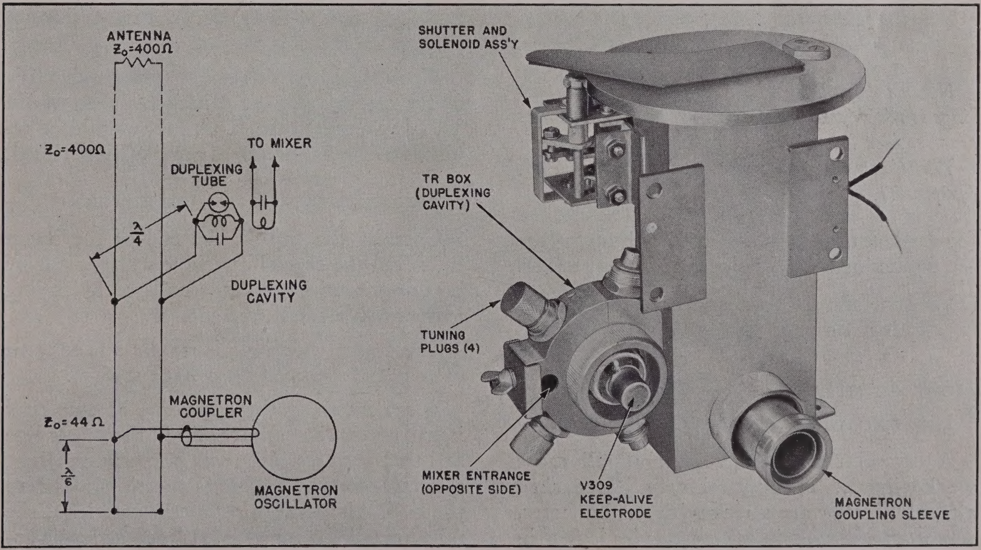

ANTENNA
Z₀=400Ω
Z₀=400Ω
TO MIXER
DUPLEXING TUBE
λ/4
DUPLEXING CAVITY
MAGNETRON COUPLER
Z₀=44 Ω
λ/6
MAGNETRON OSCILLATOR
SHUTTER AND SOLENOID ASS'Y
TR BOX (DUPLEXING CAVITY)
TUNING PLUGS (4)
MIXER ENTRANCE (OPPOSITE SIDE)
V309 KEEP-ALIVE ELECTRODE
MAGNETRON COUPLING SLEEVE

Fig. 36 — TR Box (Duplexing Cavity).

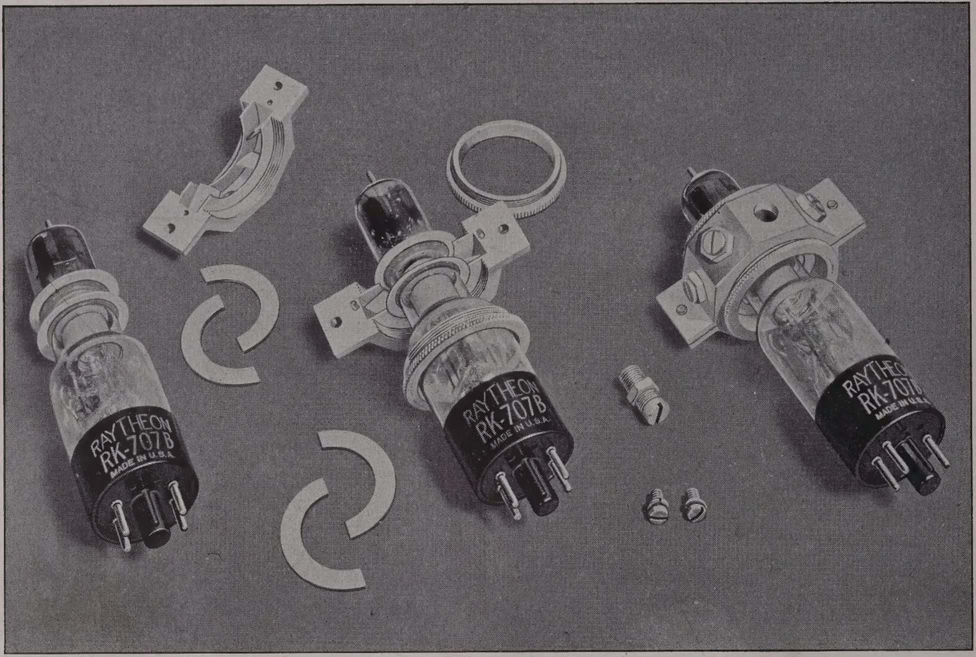


Fig. 37 — Local Oscillator (McNally) Tube and Cavity.

(d) Place a spacer ring against each tube fin, then screw on the two knurled clamping rings finger-tight. Complete the tightening of the clamping rings, using the water-pump pliers included in equipment spares.

NOTE: Insufficient tightening of the clamping rings is the chief cause of crystal failure. It can also cause sudden loss of receiver gain.

The spacer rings are not used on a few early equipments.

(e) Replace the keep-alive lead on the cap of the duplexing tube. Replace the crystal mixer.

(f) Retune the TR box and crystal mixer as outlined on page 59.

Mixer Assembly

LOCATING A FAULTY CRYSTAL

A crystal that rectifies poorly will cause weak signals. The crystal may be checked after removal by measuring with an ohmmeter, *momentarily* connecting the meter leads first in one direction and then in the other. The resistance ratio (that is, the resistance in one direction as compared with the resistance in the other direction) should be about 10-to-1 and not less than 4-to-1. Use a high-resistance scale when making checks.

Weak signals which are apparently due to a faulty crystal may be caused by a worn-out TR (duplexing) tube. This tube should be replaced every 300 hours, as previously outlined.

REPLACING THE CRYSTAL CARTRIDGE

Unscrew the cap on the end of the mixer line. Pull the crystal cartridge straight out by grasping it with the fingernails or by prying it out with a small screwdriver.

The crystal cartridge is fragile and may be damaged if dropped on a hard surface.

When inserting the cartridge, be sure that its tip enters the contact clip in the mixer line and that the cartridge seats properly. A slight resistance should be felt as the tip slides into the clip. After installing a new cartridge, the mixer must be retuned as outlined under "Tuning the R.F. System."

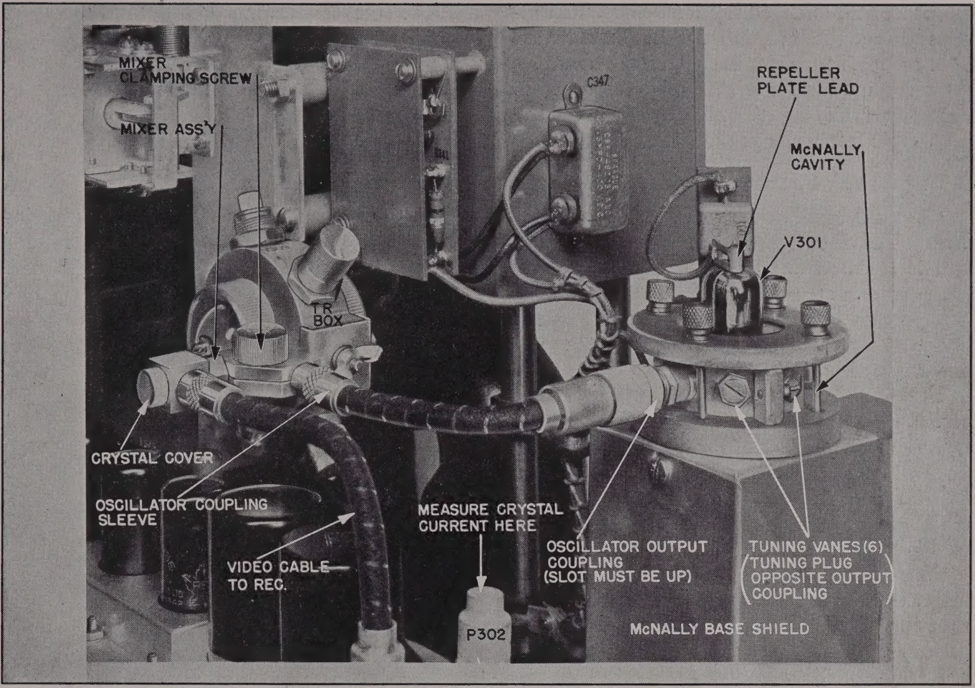

MIXER CLAMPING SCREW
MIXER ASS'Y
C347
REPELLER PLATE LEAD
McNALLY CAVITY
V301
TR BOX
CRYSTAL COVER
OSCILLATOR COUPLING SLEEVE
VIDEO CABLE— TO REC.
MEASURE CRYSTAL CURRENT HERE
P302
OSCILLATOR OUTPUT COUPLING (SLOT MUST BE UP)
TUNING VANES (6)
(TUNING PLUG OPPOSITE OUTPUT COUPLING)
McNALLY BASE SHIELD

Fig. 38 — Transmitter-Receiver: TR box and local oscillator.

Local Oscillator (*McNally Tube*)

Removal (Figs. 37 and 38)

(a) Take off the lower half of the base shield by removing the top screw and loosening the knurled nut beneath the shield.

(b) Remove repeller clip lead from top of tube.

(c) Remove the oscillator output lead (coaxial cable) from the cavity.

(d) Loosen the four captive screws clamping the cavity to the chassis and remove the top cavity clamp, taking care not to damage the repeller lead.

(e) Depress the tube lock around the base by reaching underneath the shield, pull the socket down and off the base prongs, and withdraw the tube and cavity.

(f) Take out the two screws holding the cavity together.

(g) Remove the knurled rings and drop out the split washers.

(h) Separate the cavity halves by pulling them straight apart.

Installation (Figs. 37 and 38)

(a) Cautiously clean the fins of the new tube with a soft rubber eraser, then wipe them with a soft cloth moistened with carbon tetrachloride to remove any film of oil. Finally, wipe them with a clean dry cloth. Take care to avoid injuring the thin plating on the fins.

(b) Reassemble the cavity around the tube, taking care to avoid bending the tube fins. Make sure that both these fins are outside the lips of the cavity and that the locating pin on the tube base is in line with the tuning plug.

(c) Partially tighten the screws holding the two halves of the cavity together.

(d) Drop the split washers in place and clamp them against the tube fins by tightening the threaded rings first with the fingers and then with large-jaw pliers.

(e) Complete the tightening of the screws holding the cavity halves together.

(f) Install the cavity and tube in the Transmitter Unit (see Fig. 38), reversing the procedure outlined for removal. When installing the coaxial output fitting (see Fig. 38), screw it into the cavity about two turns and lock it with the keyway on top.

(g) After replacing the tube, tune it to the proper frequency as outlined below.

TUNING THE LOCAL OSCILLATOR

The local oscillator has four tuning adjustments. TUNE SET Control G and TUNE Control H, located on the indicator panel, vary the repeller plate potential. The remaining two adjustments involve the tuning plug and the group of six cavity vanes located in the tube cavity (see Fig. 38).

TUNE SET Control G is used to set the oscillator for maximum output.[1] TUNE Control H (a vernier adjustment for TUNE SET Control G) is used to tune the oscillator over a small range. This range is insufficient to affect oscillator output materially. The adjustment of this control is outlined in Section 3, page 17.

When either the local oscillator tube or the magnetron has been changed, it may be found that the TUNE Control has insufficient range to tune the Receiver properly. If this occurs, proceed as outlined below.

NOTE: Ordinary tuning of the local oscillator by adjustment of the indicator panel controls is done with the Transmitter Unit closed as usual. Broader tuning adjustments and setting of the operating frequency band (made by rotating the tuning plug and vanes on the oscillator cavity) must be performed with the Transmitter on, and its case removed. To permit operation with the case removed, the spare r.f. choke coupler provided in tender spares should be placed on top of the r.f. section with its rectangular opening lined up with the rectangular end of the section. The transmitter chassis should then be slid under the waveguide so that the lower end of the waveguide lines up with the choke.

On units having a watertight access door, tuning can be done with the cover on and the regular choke in place.

The complete tuning procedure follows:

RETUNING BY ADJUSTING THE CAVITY PLUG

(a) Set the TUNE Control to mid-scale.

(b) Stop the Modulator by pushing STOP Button B on the Indicator.

(c) Remove P-302 (see Fig. 38).

(d) Connect a milliammeter (preferably having a scale not more than 5.0 ma. and having an internal resistance of not more than 72 ohms) from the inner connection of J-302 to ground, with the negative lead to the inner conductor.

WARNING: Never measure crystal current at J-302 with the Transmitter radiating, as stray r.f. pickup may damage the mixer crystal.

(e) Adjust the TUNE SET Control for near maximum meter reading.

NOTE: Crystal current as measured at J-302 should not exceed 0.6 ma. and should not be lower than 0.4 ma. Should the resulting current not be within these limits, loosen the clamping thumbscrew on the mixer and slide the oscillator coupling sleeve (cable nearest cavity) in or out until the meter shows an acceptable reading.

(f) Replace P-302 and start the Transmitter.

(g) Rotate the tuning plug in the oscillator cavity both ways until signals appear on the PPI. (If no targets are within range, the Resonance Chamber may be used.) If a considerable change has been made in the plug setting, it will be necessary to readjust the TUNE SET Control as above.

NOTE: The plug setting may be changed by rotating it a few turns without resetting the crystal current, provided that the current has been previously set correctly. It is not necessary to remove the transmitter cover as the plug is accessible by removing the cover plug in the side of the transmitter cover. Adjust the tuning plug with the special wrench and screwdriver provided in equipment spares.

RETUNING BY ADJUSTMENT OF CAVITY VANES

Should it be impossible to tune the oscillator to the proper frequency as outlined above, it will be necessary to adjust the vanes inside the cavity. These vanes are turned by screwdriver slots in the sides of the cavity, the slots being in the same plane as the vanes. The procedure follows:

---

[1] *The resonant frequency of the cavity is determined by the dimensions of the cavity and the adjustment of the vanes and plug. TUNE SET Control G broadly sets the oscillator frequency to correspond with the cavity frequency, thereby establishing a tuned circuit into which the oscillator operates at peak output. Since this peak on the frequency/output curve is broad, small frequency adjustments can be made within the peak by means of TUNE Control H without materially affecting oscillator output.*

(a) Remove the cover from the Transmitter-Receiver Unit and place the special choke coupler in proper alignment on the r.f. section.
(b) Slide the Transmitter with coupler into proper alignment with the waveguide.
(c) Rotate the vanes about 10°, keeping them all at the same angle with the cavity.
(d) With the Modulator off, readjust the TUNE SET Control as above.
(e) Start the Modulator and tune the cavity plug for echoes.
(f) If signals are still not received, repeat (c), (d) and (e) until signals are received.

Tuning the R. F. System

After replacement of the magnetron it is necessary to retune in order: (a) the local oscillator (McNally tube) of the Receiver, (b) the duplexing cavity, and (c) the crystal mixer.

Ordinary tuning of the local oscillator by adjustment of the panel controls is covered under "Operating Adjustments" (Sec. 3). Broader tuning adjustments and setting of the operating frequency band (made by rotating the tuning plug and vanes on the oscillator cavity) are covered earlier in the present section under "Tuning the Local Oscillator."

The tuning of the duplexing cavity and crystal mixer are covered below. These adjustments must be made with the Transmitter on and with its case removed, except on units equipped with the watertight access door.

To Retune the TR Box

(a) Pick up a stable signal and adjust the receiver gain so that the signal is below saturation. In the absence of actual signals, the Resonance Chamber (Echo Box) may be used.
(b) Adjust any or all of the four plugs around the TR box (Fig. 38) until maximum echoes are received.

To Retune the Crystal Mixer

(a) Pick up a stable signal and reduce the receiver gain until the signal is below saturation.
(b) Loosen the clamping thumbscrew on the side of the mixer (see Fig. 38) and move the end section in or out of the mixer until maximum signals are received. This adjustment is usually correct when the mixer section is about 1/32 in. from maximum insertion. Do not pull the mixer end outward more than ½ in. as damage to the inner conductor may result.
(c) Lock the setting by tightening the clamping thumbscrew on the side of the mixer.

NOTE: After the mixer has been tuned, the oscillator coupling must be readjusted as already outlined in this subsection under "Tuning the Local Oscillator."

Blower Motor

The blower motor for cooling the magnetron in the Transmitter Unit is permanently oiled and requires no further lubrication. Every three months the motor should be inspected and its brushes replaced.

This is a short-life unit with a life expectancy of about 600 hours. At the end of this period the motor should be replaced.

Rectifier Power Unit

Removal of Chassis (See Sec. 7.6)

(a) Loosen the two screws on the cover, then lift off the cover.
(b) Loosen the two securing screws on the hinged fuse and resistor panel.
(c) Raise the panel and use the bracket to hold it in place, thus exposing the terminal blocks to view.
(d) Disconnect all external leads. Carefully bend the cables down out of the way.
(e) Loosen the four screws holding the chassis in place. The chassis is now free for removal.

Reinstallation of Chassis

(a) Place the chassis in position within the case, and tighten the four screws.
(b) Raise the fuse and resistor panel. Re-form the cables and connect to the proper terminals, tightening the screws securely for good electrical contact. Make sure the cables are so formed and dressed as not to interfere with the lowering of the fuse and resistor panel.
(c) Replace the unit cover by hooking it over the studs on the top front edge of the case. *Do not force the interlock.* Secure the cover.

Servicing the Chassis in Place

(a) To gain access to the fuses and large ferruled resistors for testing, loosen the two screws on the cover, then lift off the cover.

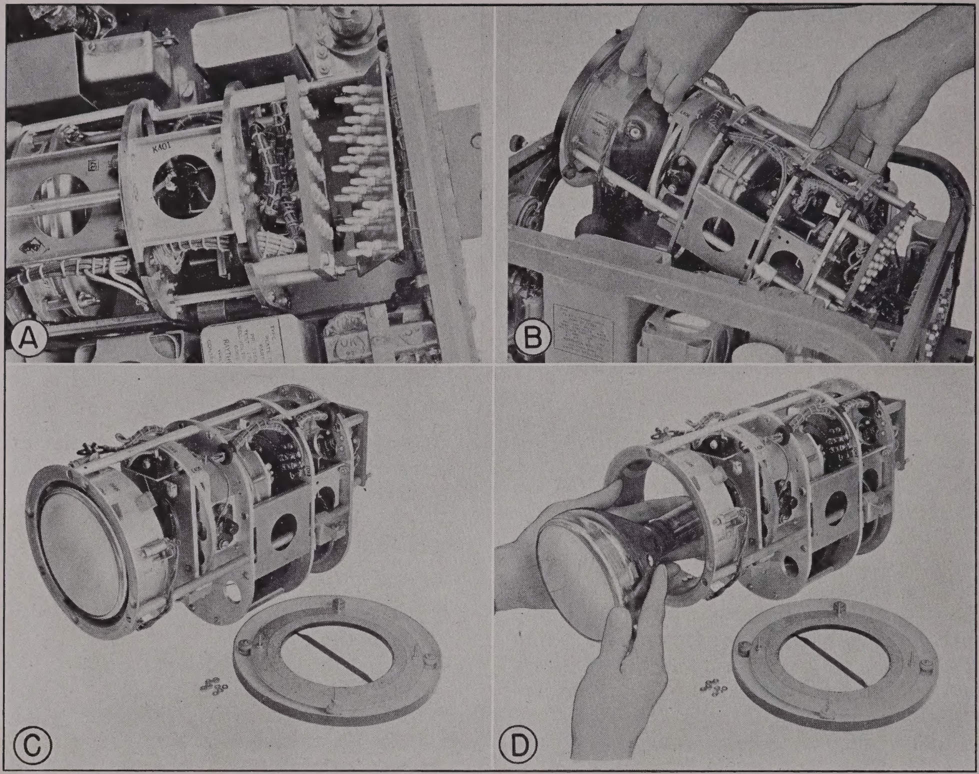


Fig. 39 — Replacement of PPI Tube.

(b) To gain access to the terminal strips, loosen the two securing screws on the hinged fuse and resistor panel, raise this panel, and use the bracket to hold it in place.

NOTE: To test the chassis while the cover is off, the interlock must be bridged.

Plan Position Indicator

Removal of Chassis

(a) Loosen the captive thumbscrews around the edge of the panel (see Fig. 7).
(b) Lift up the locking lever located on right side of case and pull out chassis.
(c) To service the chassis while operative, connect between J-401 and P-401 the test cable packed in ship's spares (see Fig. 50).

Reinstallation of Chassis

(a) First make sure that the locking lever is up, then slide the chassis into its case until it strikes the latch.
(b) Press down the locking lever and secure the captive screws.

Installation of New Unit

When the whole Indicator must be replaced, it is best to remove the terminal box housing J-401 from the old unit and install it complete with cabling on the new unit. Make sure that all seals are watertight.

Removal of PPI Subassembly

(a) First remove the Indicator chassis as previously outlined in this sub-section.
(b) Unscrew the dehydrator plugs from the subassembly.
(c) Remove the plate lead from its terminal on the flare of the PPI tube.
(d) Remove the two wing nuts on J-402 and disconnect plug board P-402 from jack board J-402 (see Fig. 39A).

(e) Loosen the four screws holding the subassembly to the indicator chassis, and vertically lift out the subassembly (see Fig. 39B).

PPI Tube

Removal (Fig. 39).

(a) Remove the PPI subassembly as previously outlined.
(b) Remove the #4 nuts holding the bearing indicator dial and face. *Do not remove the dial rollers.*
(c) Lift off the bearing vane and dial assembly (see Fig. 39C).
(d) Grasp the front edge and the tapering section of the PPI tube, using both hands, and cautiously work the tube loose from its socket. Carefully withdraw the tube from the assembly (see Fig. 39D).

Installation (Early Type)

Reverse the above procedure, making sure that the tube locating pin is properly aligned. After installation, it may be necessary to re-center the beam as follows:

(a) With the Antenna rotating, adjust CENTER Control P until the start of the sweep describes a small circle.
(b) Loosen the two wing nuts clamping the focus coil housing, and adjust the position of the coil until the circle is exactly centered on the screen. To check this centering, set the bearing vane successively to 0° and 90° and make sure that the vane bisects the circle at each setting.

Bearing Cursor (Vane)

The pressure between the cursor wheel and the rubber roller of the bearing crank will decrease as the roller wears, causing slippage. An eccentric take-up adjustment is provided by the use of an off-center shaft hole in the panel bushing. The desired pressure between the roller and the dial is obtained by loosening the nut on the panel and rotating the eccentric bushing as required. Excessive pressure will spring the cursor wheel and may jam the cursor mechanism (Sec. 8.0).

Later-type Indicators have a new-type gear drive which requires no adjustment.

Deflection Coil Drive Gears

These gears are designed to run dry and should never be lubricated (see Sec. 8.6). The small pinion gear is mounted in an adjustable eccentric bushing to provide for proper meshing of the gears. The small gear shaft bearings should be oiled quarterly with Univis P48.

Multivibrator Bias Adjustment

Before making initial tune-up adjustments it is sometimes necessary to set the square-wave multivibrator bias on the Indicator. This adjustment is performed at the factory and will usually be found correct. Should unstable sweeps be encountered, however, improper adjustment of the bias is a possible cause. Bias Control R-429 is located on the indicator chassis in the left front corner (see Sec. 8.0).

To adjust this control, proceed as follows:

(a) Remove the Indicator from its case and install the indicator test cable found in spares.
(b) Start up the equipment *but do not press the START Button on Switch B, which would start the Modulator.* Allow the equipment to warm up for a few minutes, then adjust INT Control M to about half-scale.
(c) Set Range Switch J to "80" and adjust R-429 until the multivibrator self-triggers and sweeps appear on the PPI.
(d) Retard R-429 slightly more than is necessary to cause the sweeps to disappear.
(e) Turn Range Switch J back and forth several times. If sweeps reappear on any range, readjust R-429 slightly until they disappear.
(f) Press the START Button on Switch B. Proper triggering of the multivibrator by the Modulator will be indicated by stable sweeps.
(g) Replace the Indicator in its case.

Antenna Assembly

Lubrication (Both Types)

The Antenna Assembly should be lubricated *quarterly* as follows (see Sec. 9):

(a) Refill the motor grease cups with Colonial Beacon Andok grade C lubricant.
(b) Oil the shaft bearings of the differential with Univis P48 oil.

The rest of the Antenna Assembly needs no attention for one year. At the end of this period, the assembly should be dismantled, cleaned, and relubricated as follows:

(a) Flush and refill the gear reduction box with M-285 lubricant.

(b) Lubricate the ball bearings on the antenna spindle with Andok grade C lubricant.

(c) Lubricate the main antenna drive spur gears with Colonial Beacon Tocar #1 or equivalent.

NOTE: These gears are relatively slow moving and should not be overgreased, as the excess will be thrown onto the synchro gears. When gears and bearings are excessively worn, replace them from spares.

(d) Dismantle the antenna slewing motor, and clean, inspect, and relubricate with Andok grade C lubricant.

Painting (Both Types)

The Antenna Assembly should be painted frequently. *Paint must not be applied to the Plexiglas window on the nozzle.*

Alignment of Antenna CRP-66 AFL

Alignment is required after the completion of a new installation or major repairs of the Antenna. *Alignment should never be attempted unless it is known to be necessary. It should then be performed only by personnel thoroughly familiar with the equipment.*

(a) Rotate the Antenna several times and stop it with the radial sweep of the PPI exactly at zero. The indicator micro-switch roller should now be in the exact center of the cam. (If the cam is not in the exact center of the micro-switch roller, the PPI tube must be removed and the cam centered.)

(b) Rotate the Antenna several times, stopping it so that the reflector points exactly to the bow of the ship.

(c) On the mast, open the antenna pedestal cover. Remove the synchro generator in

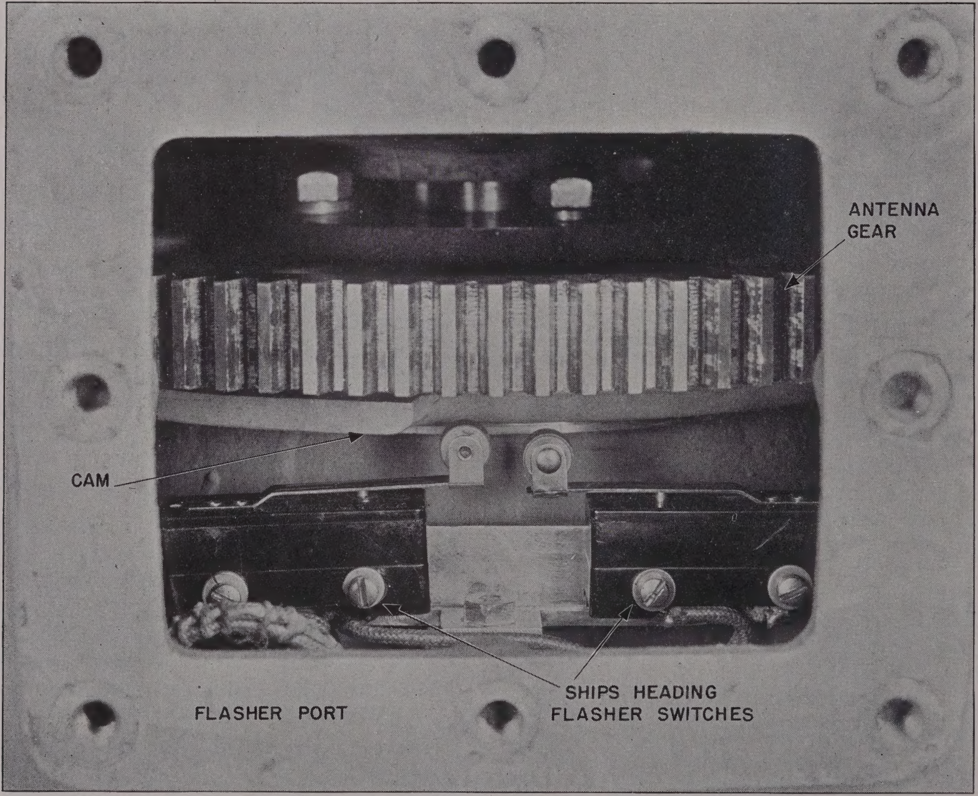


Fig. 40 — Antenna CRP-66AFL: flasher switches.

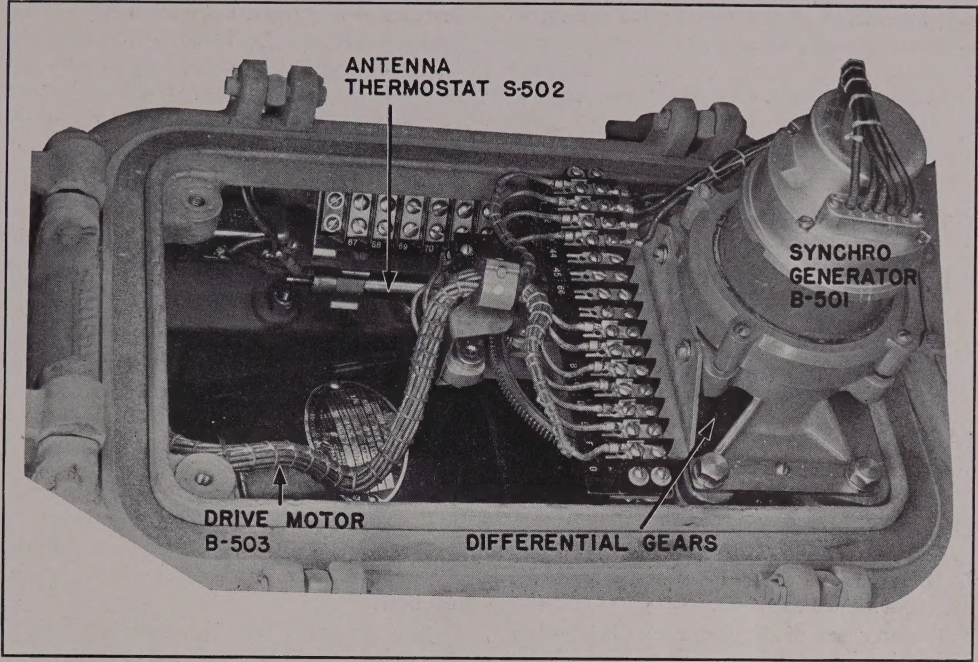

ANTENNA THERMOSTAT S-502
SYNCHRO GENERATOR B-501
DRIVE MOTOR B-503
DIFFERENTIAL GEARS

Fig. 41 — Antenna CRP-66AFL: cover open.

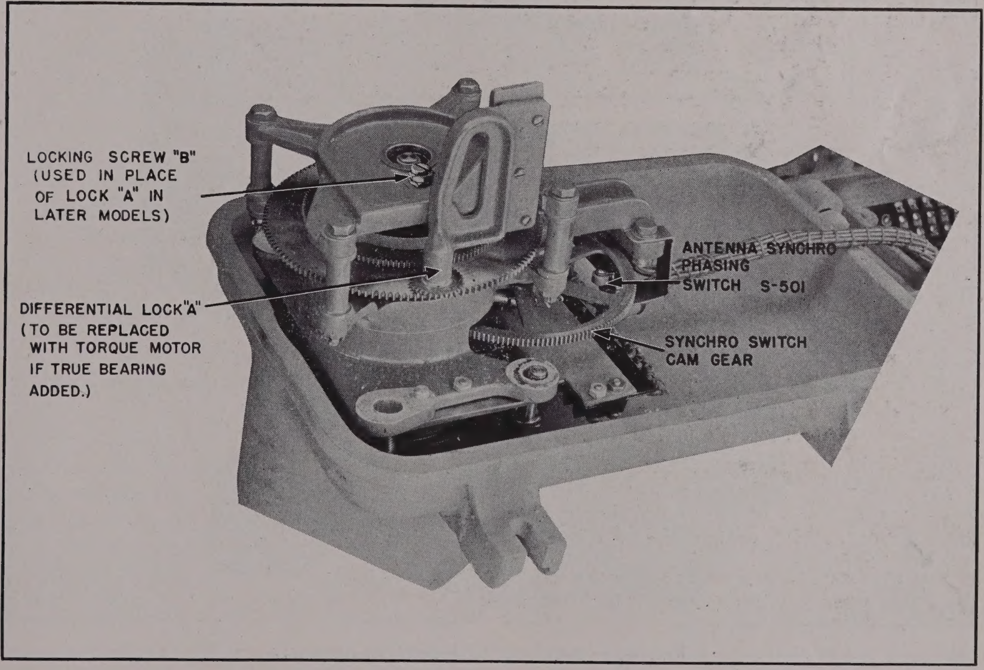

LOCKING SCREW "B" (USED IN PLACE OF LOCK "A" IN LATER MODELS)
DIFFERENTIAL LOCK "A" (TO BE REPLACED WITH TORQUE MOTOR IF TRUE BEARING ADDED.)
ANTENNA SYNCHRO PHASING SWITCH S-501
SYNCHRO SWITCH CAM GEAR

Fig. 42 — Antenna CRP-66AFL: differential removed.

the differential assembly by loosening the four clamping screws and lifting out the synchro.

(d) Loosen the cam clamping screw on the large differential gear and turn the cam arm until the micro-switch roller is in the exact center of the cam. Tighten the clamping screw.

(e) Rotate the synchro rotor until the PPI sweep is exactly at 0°. Replace the synchro, carefully meshing the coupling so as not to disturb the rotor position. Do not tighten the synchro.

(f) As the position of the synchro rotor may have changed slightly during replacement, check the position of the PPI sweep. If it has shifted from 0°, turn the body of the synchro until the sweep is exactly at 0°.

(g) Tighten the synchro clamping screw and close the cover.

(h) Start the Antenna rotating and carefully observe the PPI. If the sweep stops momentarily at 0°, the antenna cam should be repositioned as above.

The accuracy of alignment may be checked by taking simultaneous pelorus and Radar bearings on a target. Correction for any remaining error can be made by stopping the PPI at the setting corresponding to zero plus or minus the existing error, and then turning the antenna synchro until the PPI sweep indicates exactly zero.

Alignment of Antenna CRP-66AGE

Alignment is required after the completion of a new installation or major repairs of the Antenna. *Alignment should never be attempted unless it is known to be necessary. It should then be performed only by personnel thoroughly familiar with the equipment.*

Owing to its compact construction, the alignment of Antenna CRP-66AGE is far more difficult than that of the early-type Antenna CRP-66AFL. The synchro phasing micro-switch and cam are completely hidden by the antenna housing and must be adjusted by an indirect method. The procedure follows:

(a) Rotate the Antenna a few times and stop with the reflector pointed exactly to the bow.

(b) On the mast, turn the disabling (safety) switch to "Off" and remove the cover

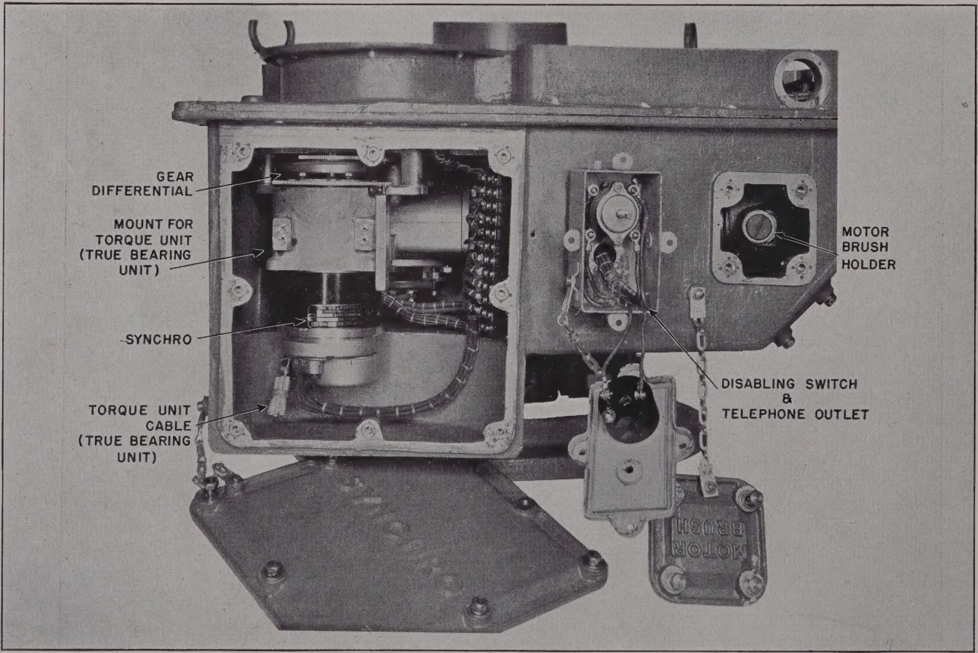

GEAR DIFFERENTIAL
MOUNT FOR TORQUE UNIT (TRUE BEARING UNIT)
SYNCHRO
TORQUE UNIT CABLE (TRUE BEARING UNIT)
MOTOR BRUSH HOLDER
DISABLING SWITCH & TELEPHONE OUTLET
MOTOR BRUSH

Fig. 43 — Antenna CRP-66AGE: details.

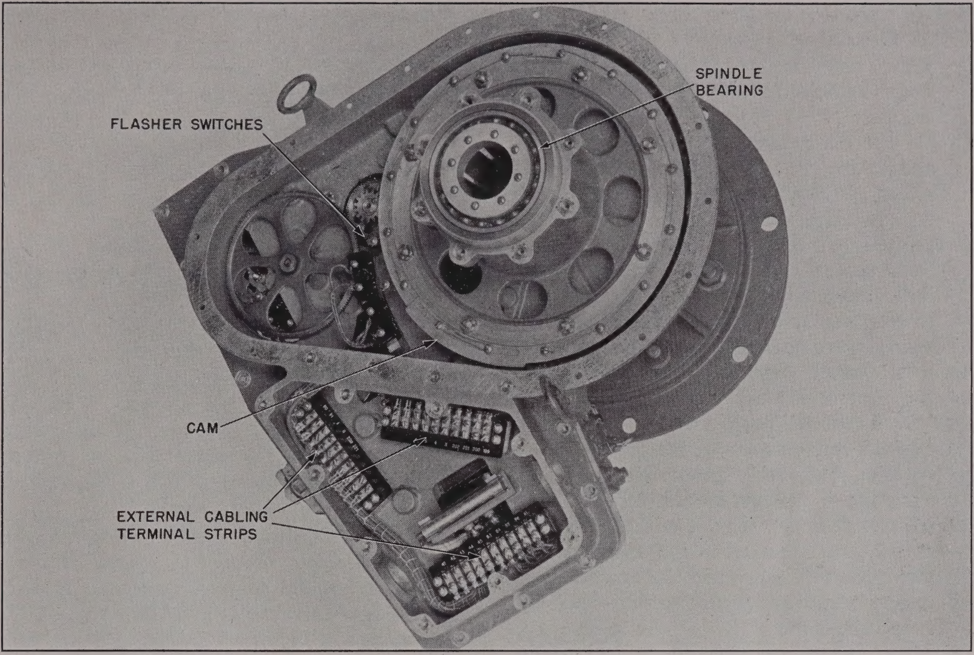


Fig. 44 — Antenna CRP-66AGE.

plate labeled "Synchro." Loosen the two screws clamping the differential locking clip and slide back the clip, thus unlocking the differential.

(c) Rotate the previously-locked large differential gear by hand until the click caused by the synchronizing micro-switch is heard. By turning the gear through a small arc, determine the points where the micro-switch roller just contacts the cam and just rolls off the cam. Count the gear teeth between these points with reference to the locking clip and lock the gear with the clip halfway between the above limits. This adjustment should now be such that the micro-switch roller is in the exact center of the cam.

(d) After closing the disabling switch, move out of the way of the reflector and have someone rotate the Antenna several revolutions, stopping with the reflector pointed exactly to the bow. Open the disabling switch.

NOTE: This step may be omitted if the PPI sweep was within 8° of 0° on the bearing dial during step (c), or if it is found easier to remove the antenna synchro completely and to turn the rotor a few revolutions. Step (d) is included because, after setting the synchro phasing switch, a few revolutions of the Antenna will re-synchronize the system so that the sweep will be within 8° of the antenna bearing; and the only remaining adjustment required will be to turn the synchro body no more than 180°.

(e) Loosen the three synchro clamping screws and turn the synchro body until the PPI sweep is exactly at 0°. Lock the synchro in place. Check the synchro coupling for proper mesh since it may have become disengaged during the synchro loosening operation. Replace the cover plate and close the disabling switch.

NOTE: See method of checking accuracy of alignment outlined at the end of "Alignment Procedure for Antenna CRP-66AFL."

Adjustment of the Ship Heading Flasher (True-Bearing Systems).

The flasher is much easier to adjust than the synchro, since the flasher switches and cam are both visible and accessible. After the true-bearing accessories have been added, the flasher should be adjusted as follows:

(a) Rotate the Antenna several times and stop with the reflector pointed exactly towards the bow.

(b) On the mast, open the disabling switch, and remove the cover plate marked "Switch Access." Examine the position of the micro-switches to make sure that they are properly tripped by the cam.

(c) Remove the slotted cam (secured to the large antenna gear) by taking out two screws, replacing the screws. It may be necessary to rotate the Antenna partially to find and remove the cam. In this event, the Antenna must be returned to the "Dead Ahead" position.

(d) Lay the cam on the antenna gear in such a position that, if the Antenna were rotating, one edge of the cam would just strike micro-switch S-504 (the one with three leads) as the cam approaches the switches. Remove the two screws in the antenna gear under the cam and, using these two screws, secure the cam.

(e) Move free of the reflector and close the disabling switch. Have someone operate the True-Relative Switch on the Bearing Control Unit to "Relative," and then rotate the Antenna. If the flash does not occur exactly at 0°, open the disabling switch, loosen the two screws securing the cam, and slip the cam in the proper direction until the flash occurs exactly at 0° when the Antenna is rotated as above.

(f) Lock all adjustments, replace the cover plate, and close the disabling switch.

Checking the Synchro Phasing System

(a) Remove power from the equipment and turn either the PPI sweep coil or the Antenna by hand through at least 36°.

(b) Start the equipment and rotate the Antenna electrically. When the sweep reaches zero it will lock and remain locked until the Antenna also reaches zero, at which time the sweep and the Antenna will rotate in synchronism. This action should be checked with the Antenna rotating first clockwise and then counterclockwise.

(c) If the Antenna and sweep do not synchronize, look for trouble in the antenna micro-switch S-401, the indicator micro-switch S-408, relay K-401, or fuse F-204.

Antenna Space Heaters

The antenna space heaters should be frequently checked for proper operation, particularly during cold weather. The thermostat in the Antenna is adjusted to open and shut off the heater at a temperature between 0° and 25° *Centigrade*. The heaters need not be checked at the Antenna, since they may be checked at the Junction Box as follows:

(a) Disconnect the external cabling to terminals 65 and 66 on E-1307 in the Junction Box.

(b) Open terminal 80 on E-1308 in the Junction Box and insert a 0–5 d.c. ammeter. If the heaters are not operating the current will be approximately 0.3 amperes, which is the drive motor field current. If the heaters are operating, the current will be approximately 1.8 amperes, which is the sum of the heater and field currents.

NOTE: The ammeter must be inserted in terminal 80 instead of terminal 81; otherwise the current for the synchro phasing system will be read. By putting the ammeter in series with terminal 80, the synchro phasing circuit is eliminated and only the heater and motor field current will be indicated.

Junction Box

The Junction Box may be opened for inspection by loosening the captive screws around the cover, raising the cover slightly, and swinging it back on its hinges. The antenna relays, resistors, and capacitors are now exposed for servicing. If it is desired to inspect the external cabling terminal strips, the relay panel may be raised by loosening two captive screws at the corners and raising the panel on its hinges. A locking device is employed to hold the relay panel open while working on the terminal strips.

Since the Junction Box is watertight and may be mounted outside, all cable entrances are made through terminal tubes. These should be inspected frequently for leakage and repacked when necessary. The two silica-gel dehydrators in the unit should be inspected at least quarterly and replaced when exhausted.

Waveguide

The waveguide does not require the careful maintenance and periodic inspection of a gas-filled coaxial line. Low sensitivity, however, has sometimes been traced to water, metallic scale, dirt, sawdust, rags, etc., in the waveguide.

Since the waveguide is not gas-filled, water often forms through condensation. This water tends to collect at the bottom of the guide, causing erratic operation. The collected water should be regularly drained by raising the rubber boot between the Transmitter and the waveguide.

When metallic scale is present, it often shows up as audible arcing within the waveguide. If this occurs, the waveguide should be cleaned. If any scale remains after cleaning, the waveguide should be replaced.

During installation, the waveguide should be bonded to the ship's ground system and then painted to prevent corrosion.

Should water traps (low places) be present in the waveguide run, a 1/16″ drainage hole should be drilled through the waveguide at the lowest point. After drilling, all burrs must be removed from inside the guide.

Miscellaneous

IFF Control Unit and Line Voltmeter

To open the unit for servicing, loosen the two knurled thumbscrews on the front panel and drop the front half on its hinges (see Sec. 8.8).

Accessory Control Unit

REMOVAL AND REPLACEMENT

Procedures are the same as for the Indicator.

SERVICING

For servicing the chassis while operative, the indicator test cable can be connected between J-701 and P-701.

Further information on servicing is included in the A.C.U. Instruction Book.

Replacement of Tubes

All tubes are secured in their sockets by locking devices which keep them firmly in place under shock and vibration. These locks must be released before the tubes are removed from their sockets.

To remove one of the conventional-type glass tubes, depress the spring grips at its base and withdraw the tube.

To remove either of the first two i.f. tubes V-301 and V-302 in the Receiver, unscrew the cylindrical shield covering the tube.

To remove any of the six remaining tubes V-303–V-308 in the Receiver, first remove the tube base clamping plate which is held in place by two round-headed machine screws.

The removal of special tubes is described under the units in which they are located.

Dehydrator Plugs

The dehydrator plugs ("Protek-Plugs") used in the Transmitter-Receiver, Indicator, Accessory Control Unit, and Junction Box become exhausted after a time and must be replaced. The life of these plugs depends mainly on the tightness of the seals on the unit cases and the number of times that these seals are disturbed. Normally the plugs will dehydrate the units several times after initial installation and sealing. If, however, the seals leak, earlier replacement may be necessary.

The condition of the two long dehydrator plugs is roughly shown by the small pilot plug in the indicator panel and in the side of the transmitter case. When new, all plugs are deep blue in color; as they absorb the moisture within the units, all plugs change to a light pink.

Whenever either unit has been opened, the long dehydrator plugs should be examined before resealing the case. If both long plugs are still blue for half their length or more, they need not be replaced; but if either plug is blue for less than half its length, both should be replaced. If the pilot plug is pink while the long plugs are satisfactory, the pilot plug only need be changed.

The unit cases should not be left open longer than necessary. *As soon as a case is opened, the perforated ends of the dehydrator plugs should be sealed with Scotch tape or masking tape to prevent absorption of moisture from the open air.*

Spare dehydrator plugs are supplied in small sealed tins and may be found in ship's spares. A color chart is included in each tin which shows the appearance of the plugs in various stages of exhaustion.

Replacement of the dehydrator plugs is accomplished by unscrewing the exhausted plug from its mounting socket and screwing in a new plug. The red sealing wax disk should be removed from the new plug just before mounting it.

The dehydrator plugs may be successfully reclaimed by baking them at a moderate temperature (200° F.) for 1½ times as long as is required to restore the normal blue color.

Cables and Connectors

Cables, terminals, jacks, and plugs should be frequently inspected and repaired, tightened or replaced from tender spares when necessary. Occasional cable failure is inevitable, especially in cables subjected to frequent bending. Coaxial cables are liable to short owing to flowing of the soft dielectric.

Jack and plug connectors employed on removable units should be frequently inspected and cleaned when necessary. These units should never be forced into place as bending of the contacts may result. When replacing the Indicator or A.C.U., the chassis release lever at the right rear of the unit must be operated properly.

Terminal connections should be so dressed that there is no likelihood of short circuits or chafing between the leads and moving parts or cases.

If individual leads open in any of the existing cables, the spares in the cables may be used until new cables can be installed. A continuity tester is useful in locating spares and in checking the color coding.

The pulse cable leading from the Modulator to the Transmitter employs a semisolid dielectric. This cable should be kept free of sharp bends to prevent "flowing" of the center conductor toward the shield. To prevent breakage from vibration, the lead should be installed at the Modulator with a moderately long loop and should be well supported by clamps and connectors. The minimum bending radius is five inches. This also applies to the trigger and IFF trigger cables leading from the Modulator.

When it becomes necessary to replace coaxial cables, carefully dismantle the connectors and note or sketch the manner in which they were assembled. Prepare the new cable ends exactly like the old, carefully soldering the leads and using as little heat as proper soldering requires. This precaution may prevent damage to the dielectric. When installing or replacing the pulse cable, the dielectric should be handled as little as possible and should be scraped lightly or cleaned of dirt and flux after the soldered connections have been made. (See the cable assembly procedures following this page.)

Electrical Contacts

All electrical rotating contacts (such as are found on the Motor-Alternator, exciter, blower motor, speed regulator, spark gap, slewing motor, and PPI sweep coil) should be frequently checked for brush wear and for dirty, worn, or pitted surfaces. Brushes for all units will be found boxed and labeled in equipment spares. Slip rings and commutator segments should be cleaned with canvas pads or, if extremely worn or oxidized, with fine sandpaper or crocus cloth. *Do not use emery cloth on commutators or slip rings.* Brush tension should be even and the brushes should be free in their holders.

ASSEMBLY PROCEDURE FOR SPECIAL TERMINAL TUBE
(Early Type)

Transmitter End of Pulse Cable

(The identifying letters in the illustration refer to the corresponding steps below.)

(a) Cut the cable to the proper length and fray the armor over the end of the cable. Disassemble the terminal tube.

(b) Slip the packing nut over the cable. Cut the armor and neoprene back 2½″, taking care not to damage the inner braid.

(c) Cut the armor back another ½″, then unbraid and cut back the double inner braid until it extends ½″ beyond the end of the neoprene. Slip the spanner nut over the neoprene with the spanner holes toward the packing nut.

(d) Slip the flat washer over the neoprene. Unbraid the double inner braid up to the neoprene, and flare the braid at right angles to the cable. Slip the washer against the flared braid and trim the braid circularly to the washer diameter.

(e) Slip the cable into the terminal tube so that the flared braid rests against the shoulder in the bottom of the tube. Using the special spanner wrench, run the spanner nut into the tube until the inner braid is securely clamped to the tube.

(f) Fill the tube with a layer of hard packing, a layer of soft packing, and a layer of hard packing; and tighten the packing nut. Remove the packing nut and force the armor into the tube as far as it will go. Place a round of metallic packing over the armor and tighten the packing nut.

Owing to the short packing length, this tube will be superseded by a tube of improved design.

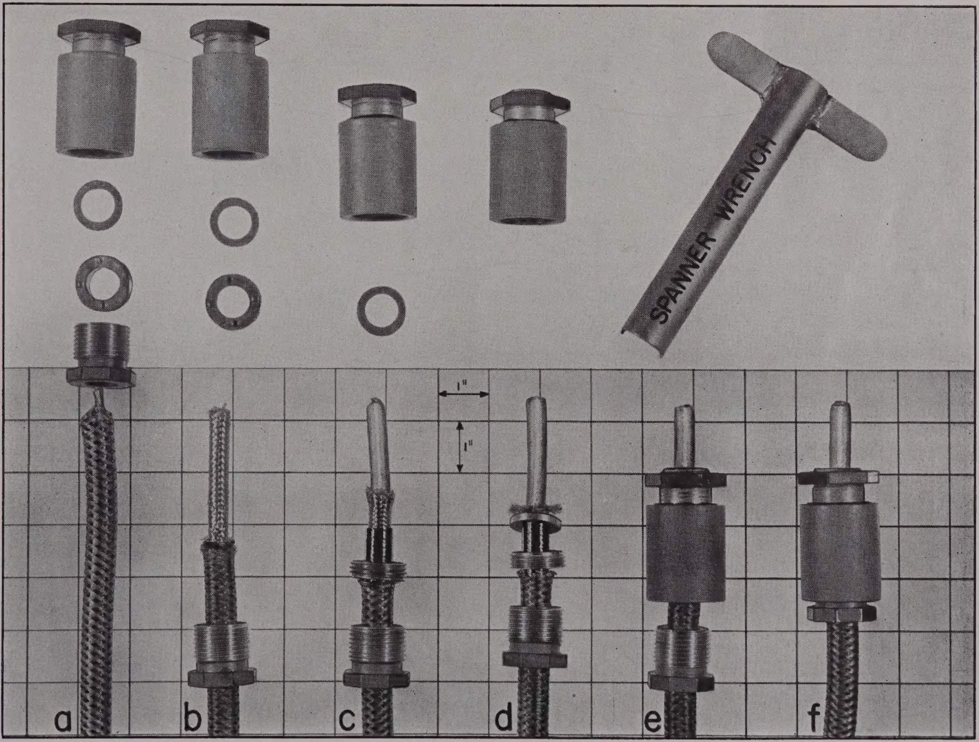


FIG. 45.

ASSEMBLY PROCEDURE FOR SPECIAL TERMINAL TUBE (Later Type)

Transmitter End of Pulse Cable

(The identifying letters in the illustration refer to the corresponding steps below.)

(a) Cut the cable to the proper length. Fray and twist the armor over the end of the cable. Disassemble the terminal tube, and slip the armor locking nut and the large conical ferrule over the cable.

(b) Cut the armor and neoprene back 2½″, taking care not to damage the inner braid.

(c) Cut back the armor 2″ farther, and then slide the armor, armor locking nut, and ferrule back on the cable, out of the way. Slip the gland nut, packing washer, rubber packing, and spanner nut (holes toward packing) over the neoprene. Slip the small conical ferrule over the braid, up to the neoprene. Unbraid the inner braid back to the ferrule and flare back over the conical ferrule. Trim excess circularly to the ferrule diameter.

(d) Slip the cable into the terminal tube so that the flared braid rests against the conical shoulder in the bottom of the tube. Using the special spanner wrench, run the spanner nut into the tube until the inner braid is securely clamped inside. Flare the armor back over the large conical ferrule.

(e) Slide the rubber packing, flat packing washer, and necessary split washers into the stuffing tube and tighten the gland packing nut. The nut should begin compressing the rubber at a point about 3⁄16″ before it seats. If the compression is insufficient, loosen the packing nut and insert additional split washers. Pull the armor back in place, slipping the conical ferrule against it. Trim the excess armor circularly to the ferrule diameter.

(f) Slide the cap nut in place and tighten securely. Cable strain should be taken completely by the armor.

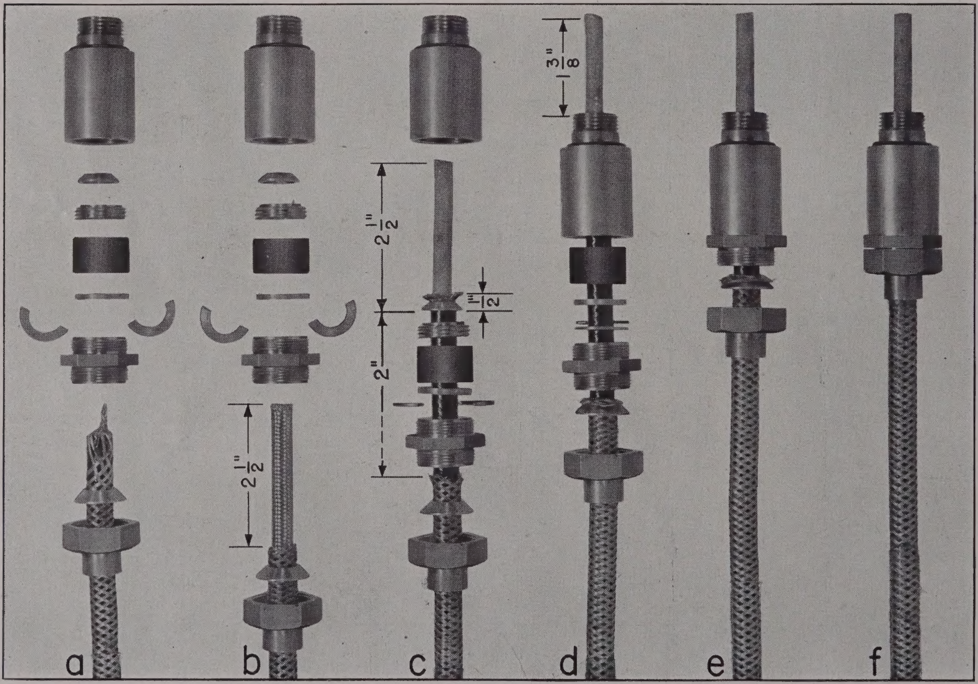


Fig. 46.

ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR

Modulator End of Pulse Cable

(The identifying letters in the illustration refer to the corresponding steps below.)

(a) Cut cable to correct length. Fray ends of armor over cable end. Disassemble the connector.

(b) Slip threaded sleeve over cable. Cut the armor back 7¾″.

(c) Cut the neoprene back 7¾″, taking care not to damage the inner braid, and slip the conical ferrule over the double inner braid.

(d) Force the ferrule under the neoprene and cut off the double inner braid about 1/16″ beyond the end of the ferrule. When cutting the inner braid be very careful not to damage the soft dielectric. Form the braid to the inside of the ferrule. Slip the coupling union on the cable after scraping the soft dielectric to free of foreign matter.

(e) Force the tapered portion of the coupling union under the inner braid and ferrule. Trim off excess braid and armor.

(f) Pull the sleeve toward the coupling union and screw together, tightening with open-end wrenches. Remove the soft dielectric from the last ½″ of the cable for connection.

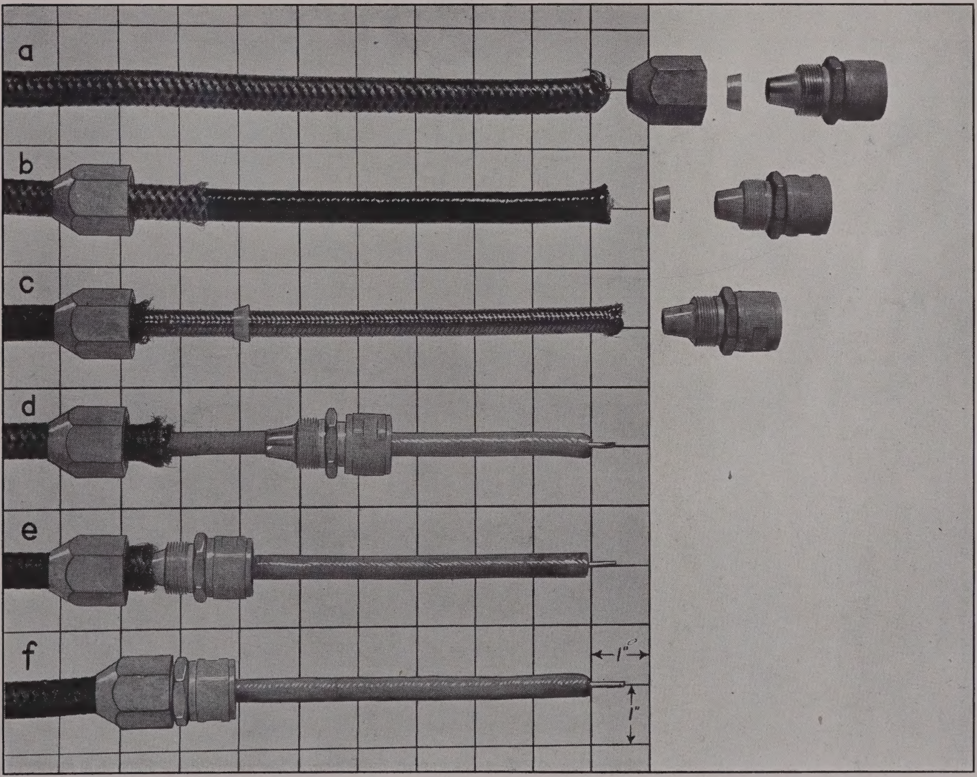


Fig. 47.

ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR

Antenna End of Echo Box Cable
And Modulator End of IFF and Trigger Cables

(The identifying letters in the illustration refer to the corresponding steps below.)

(a) Cut the coax cable to the proper length. Dismantle the connector.

(b) Fray the end of the armor over the end of the cable and slip on the union nut and sleeve.

(c) Cut the armor and neoprene back 1″ from the end of the cable, taking care to avoid cutting the inner braid.

(d) Fray the inner braid over the end of the cable and slip the ferrule over the braid (tapered end first).

(e) Force the tapered end of the ferrule under the neoprene. Trim the inner braid about ⅛″ beyond the ferrule and flare over the ferrule. Cut the semi-solid dielectric so that it extends ¼″ beyond the end of the ferrule.

(f) Carefully tin the bare inner conductor with *rosin core solder* using a small soldering iron. USE THE SMALLEST POSSIBLE AMOUNT OF HEAT CONSISTENT WITH GOOD SOLDERING AS HEAT DAMAGES THE DIELECTRIC. Tin the inside of the tip connector. Insert the inner conductor into the tip and *sweat* together. Any globules of solder on the tip must be removed. Unbraid the armor back about ⅜″ and slip the sleeve over the armor and ferrule. This fit is quite tight, and two pairs of pliers may be required to force the sleeve over the ferrule.

(g) Trim off excess armor and slip the main connector assembly into place. The tip must pass through the polystyrene bushing in the connector. Slide the union nut up and screw the connector halves together, using open-end wrenches for tightening.

NOTE: To insure a watertight assembly, the rubber washers on the ferrule and inside of the main connector assembly must be in place.

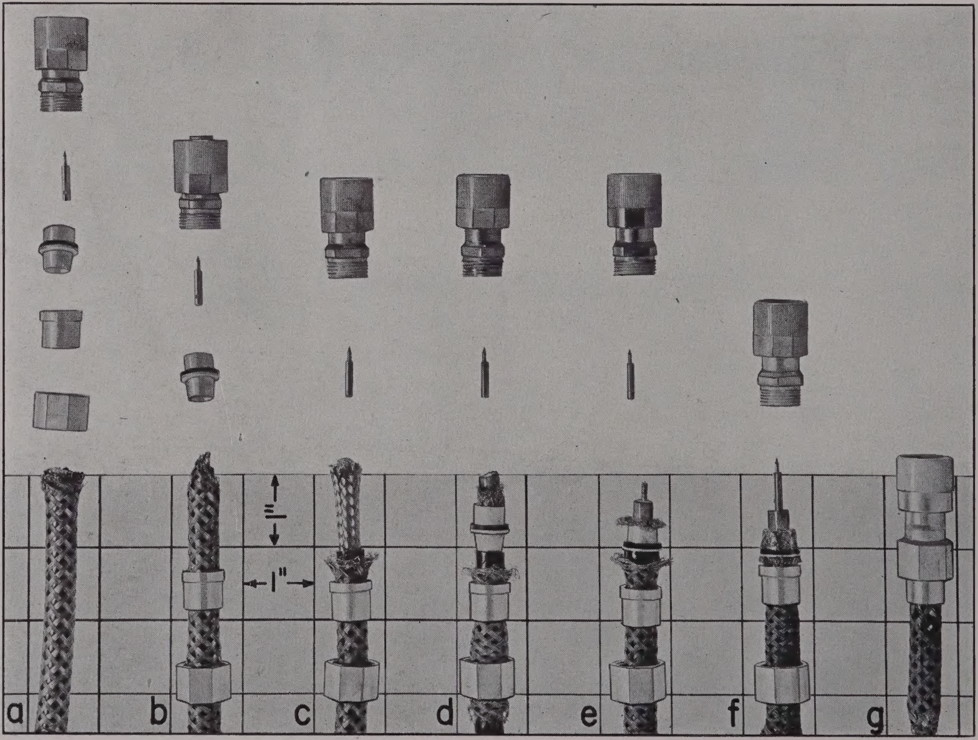


FIG. 48.

ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR

Echo Box End of Echo Box Cable

(The identifying letters in the illustration refer to the corresponding steps below.)

(a) Cut cable to proper length. Fray armor over end of cable and slip sleeve on cable.

(b) Cut armor and neoprene back 1″, taking care not to damage the inner braid.

(c) Fray inner braid over end of cable and slip on the conical ferrule over the braid and under the neoprene for about half the length of the ferrule. Trim the inner braid about ⅛″ beyond the ferrule and fold the braid over the edge of the ferrule. Cut back the semi-solid dielectric ¼″. Do NOT TOUCH OR HANDLE THE DIELECTRIC ANY MORE THAN NECESSARY.

(d) Carefully tin the inner conductor with a *small* soldering iron. HEAT DAMAGES THE DIELECTRIC AND THE LEAST POSSIBLE AMOUNT OF HEAT SHOULD BE USED CONSISTENT WITH GOOD SOLDERING. Tin the inside of the small tip connector. Insert the inner conductor into the tip and *sweat* together. Any solder globules on the outside of the tip must be removed.

(e) After making certain the dielectric is free of foreign material, slide the main connector assembly on the cable with the tapered section *underneath* the inner braid and ferrule. Slip the armor up on the ferrule.

(f) Slip sleeve toward main connector and screw together, tightening with open-end wrenches.

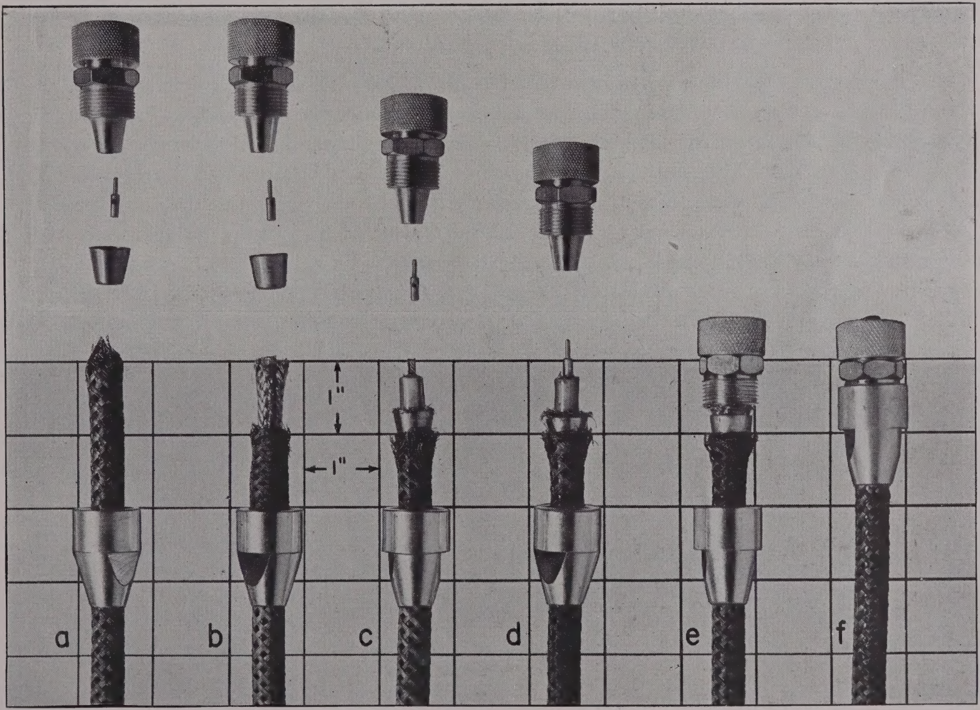


Fig. 49.

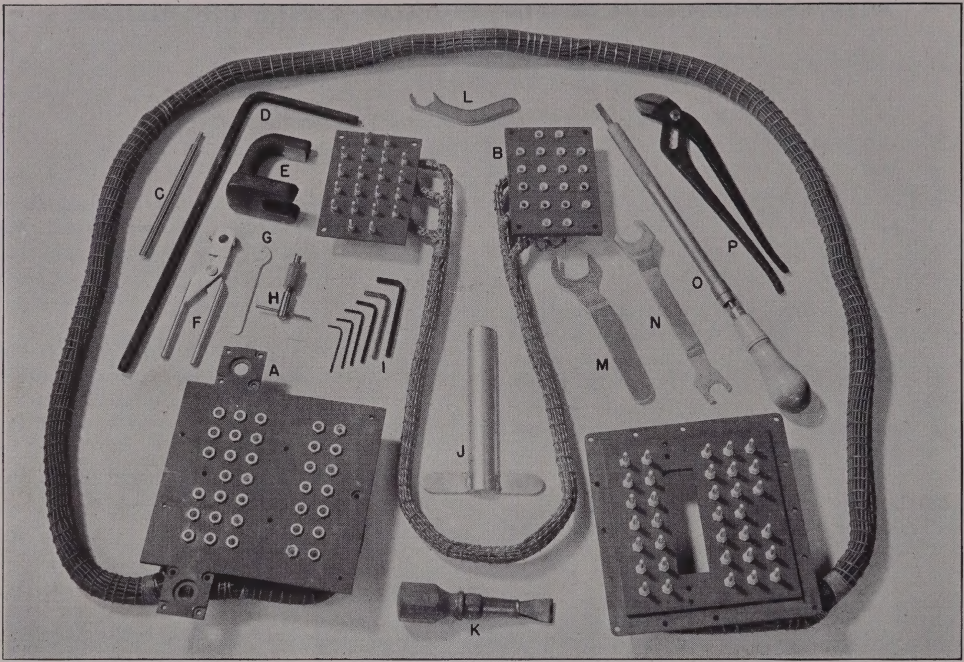


Fig. 50 — Special Tools Included in Equipment Spares. (A) Indicator test cable for operating Indicator after removal from case; (B) test cable for operating PPI assembly after removal from Indicator; (C) wrench for making gap-phasing adjustments; (D) Allen wrench (large) used on studs fastening spark-gap housing to end of Alternator; (E) gauge for adjusting anode tip of magnetron to proper length; (F) pliers for holding lower section of magnetron anode tip when removing or installing tip assembly; (G) spanner wrench for removing or installing ball end of magnetron anode tip; (H) spanner key for removing or installing magnetron anode tip; (I) Allen wrenches for adjusting various setscrews; (J) spanner wrench for tightening braid clamp of stuffing tube on pulse cable; (K) screwdriver for removing plastic shipping plugs; (L) wrench for adjusting locknuts on TR box; (M) offset wrench for eccentric adjustment of bearing hand-crank in Indicator; (N) wrench for nuts on indicator panel; (O) combination wrench and screwdriver for tuning local oscillator cavity through the case; (P) waterpump pliers for general-purpose work, such as tightening clamping rings on local oscillator cavity and TR box.

Section 5—Motor-Alternator-Modulator

5.0 GENERAL

The Motor-Alternator-Modulator consists of the 115-volt d.c. drive motor and the 115-volt 400-cycle Alternator with its exciter and voltage regulator, a rotary spark gap mechanically coupled to the alternator shaft, and a Modulator.

The Motor-Alternator converts the ship's power into 400-cycle alternating current having well-regulated voltage and frequency characteristics. The 400-cycle output operates all major units of the equipment; while the ship's d.c. supply is used directly to operate the Antenna, the blower motor, the waveguide shutter solenoid, the control circuits, and antenna space heaters.

In the Modulator the 400-cycle voltage is stepped up by a transformer to 9.5 kv., rectified, and used to charge a pulse-forming line. A synchronized spark gap discharges this line once every 2500 microseconds (400 times per second), generating a one-microsecond square-wave pulse. This pulse is applied to a step-up transformer in the Transmitter, which delivers a high-voltage keying impulse to the magnetron oscillator.

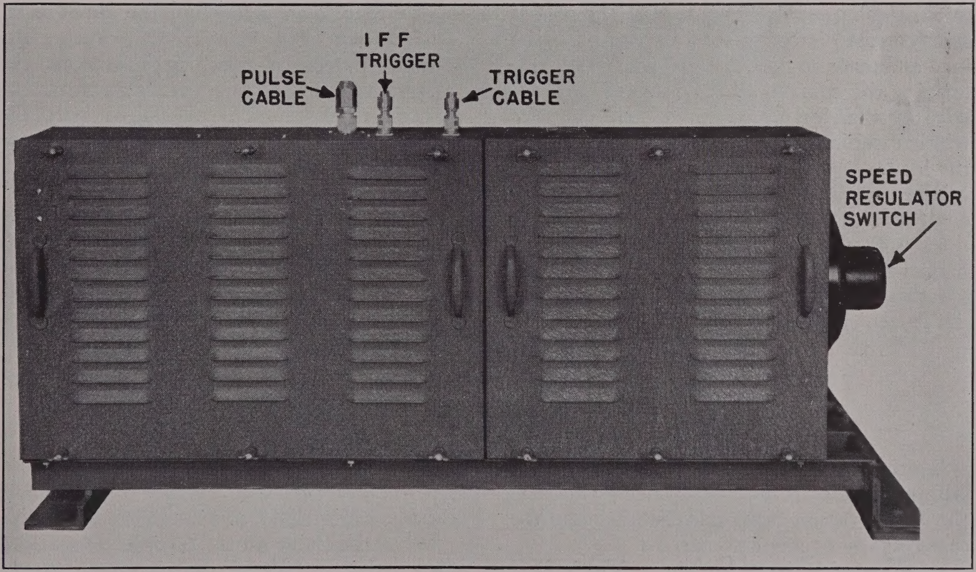


Fig. 51 — Motor-Alternator-Modulator: modulator side.

5.1 DRIVE MOTOR AND MAGNETIC CONTROLLER

The Motor is of the 4-pole, compound-wound type, and is of conventional design. It has a two-stage automatic starter as well as a speed regulator. Speed regulation is required in order to insure proper voltage regulation and correct alternator frequency. A noise filter is included in the motor circuit to reduce interference with communications equipment.

Two makes of motors are currently used, the Leland and the Murray (Imperial). Both types are electrically equivalent and mechanically almost identical. Lubrication and maintenance instructions will be found in Sec. 4. Replacement parts not directly interchangeable are shown in the parts lists.

The Magnetic Controller contains, in addition to the main line contactor, a two-stage automatic starter. The starter prevents destructive high currents from passing through the armature during starting. A thermal overload switch is also included to protect the equipment from overloads.

The starter consists of a 1½-ohm resistor grid (starting resistance) and an acceleration relay. The latter has two coils which act upon the relay plunger in opposite directions. The upper coil (voltage) is energized from the 115-volt d.c. line and tends to pull the plunger upward, closing a pair of contacts. The second coil (current) is connected in series with the load and tends to pull the plunger downward, opening the contacts. The contacts are paralleled by the starting resistance grid, and the whole combination is connected in series with the load.

When starting the Drive Motor, the counter-e.m.f. of the motor armature is zero when the rotor is at rest, building up as the rotor speed increases. This causes the motor starting current to be extremely high. High current through the current coil causes the accelerating relay plunger to be pulled downward, thus opening the contacts and inserting the starting resistance in series with the Motor. The value of the resistance is such that the maximum motor current is limited to about 75 amps. Without the starting resistance the maximum starting current would approach 200 amps.

As the Motor gains speed, the motor current decreases until the voltage coil has the greater pull, thus closing the contacts. This short-circuits the starting resistor and connects the Motor directly across the line.

The main contactor is controlled by a remote push-button station. The contactor holding coil is energized from the 115-volt d.c. line through several interlocks, a set of relay contacts (K-111), a thermal overload switch, and the "Stop" push button. Relay K-111 is so connected that should the motor shunt field circuit open, the Drive Motor cannot "run away" as a series motor, because in that event relay K-111 would open, causing the Magnetic Controller to open, shutting off the power.

When the "Stop" push button of the remote station is pressed, the contactor opens, shutting off the power. If the button is held down for only a fraction of a second, the decelerating motor operates as a generator, causing current to pass through the shunt field. This current closes relay K-111, causing the main contactor to close, again starting the equipment. In stopping the equipment, the "Stop" button must be held down until the voltage generated by the Motor is too low to close K-111 — ordinarily about five seconds.

NOTE: A few random equipments use the CABS-24241 positive action push-button station. Since the "Stop" button on this type remains open when operated, it is not necessary to hold the button depressed for five seconds.

5.2 SPEED REGULATOR

Control of motor speed with varying line voltages and loads is accomplished by varying the motor shunt field current through the centrifugally operated switch S-107.

In series with the motor shunt field is fixed resistor R-120, variable resistor R-114, and the coil of relay K-111. Connected across R-120 is centrifugal switch S-107, which is mounted on the free end of the Drive Motor (see Fig. 25).

When the Drive Motor exceeds the specified speed, the centrifugal switch closes, short-circuiting R-120 and thus increasing the shunt

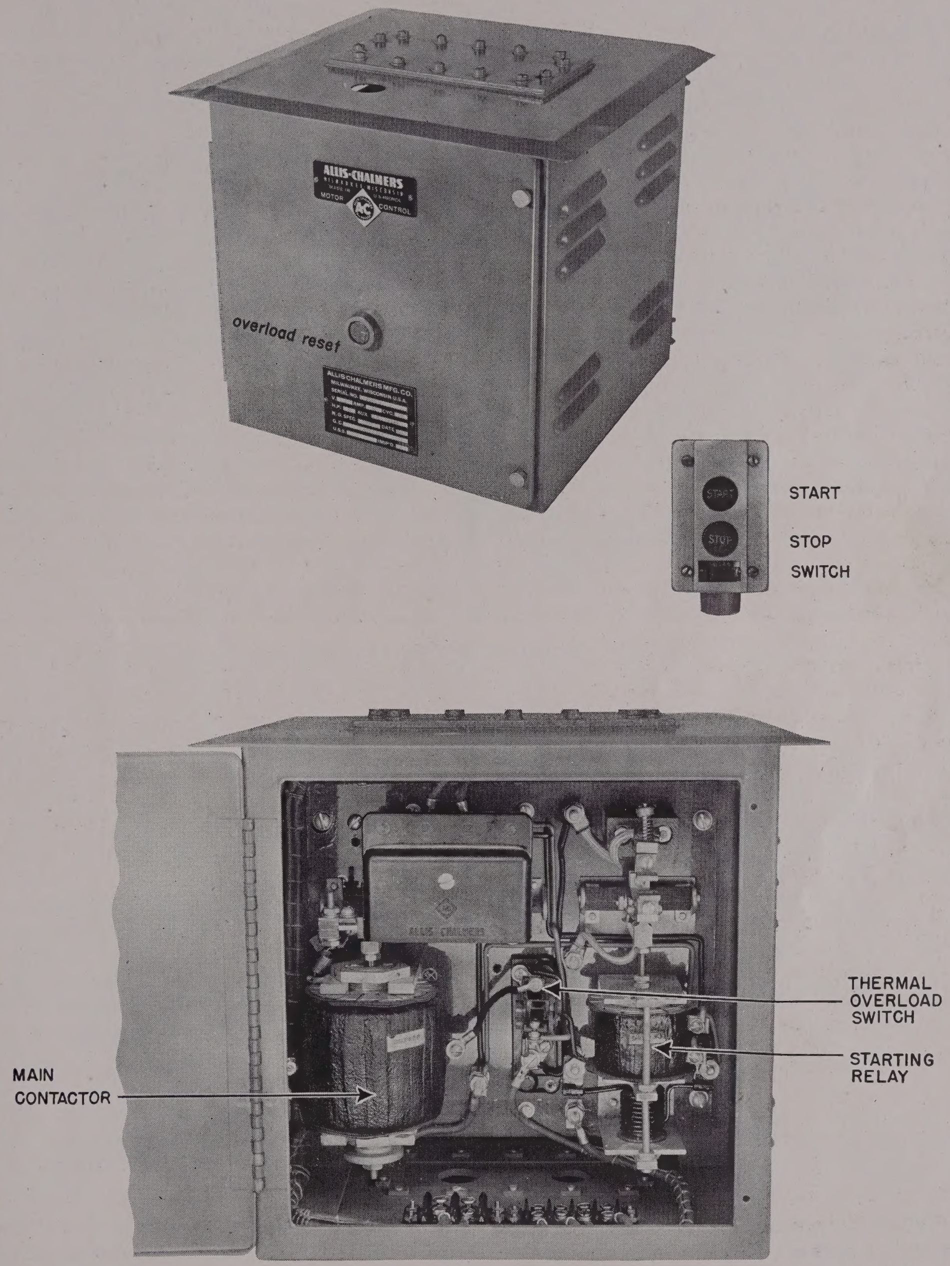

ALLIS-CHALMERS
MOTOR
CONTROL
overload reset
START
STOP
SWITCH
THERMAL
OVERLOAD
SWITCH
STARTING
RELAY
MAIN
CONTACTOR

Fig. 52 — Magnetic Controller and Start-Stop Push Button Switch.

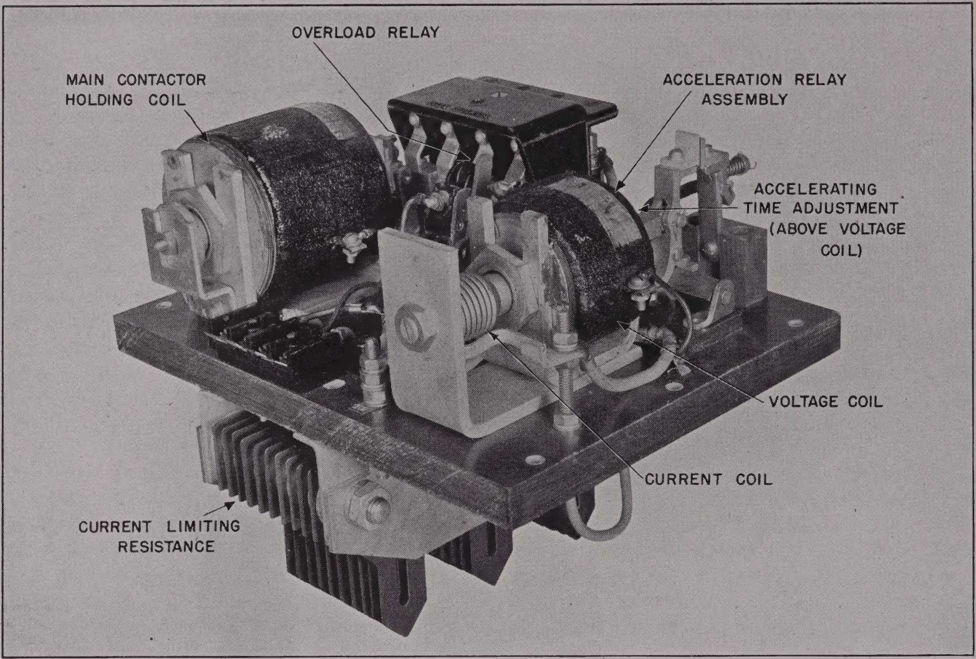

OVERLOAD RELAY
MAIN CONTACTOR HOLDING COIL
ACCELERATION RELAY ASSEMBLY
ACCELERATING TIME ADJUSTMENT (ABOVE VOLTAGE COIL)
VOLTAGE COIL
CURRENT COIL
CURRENT LIMITING RESISTANCE

Fig. 53 — Magnetic Controller: chassis.

field current. An increase in the shunt field intensity results in a slowing down of the Motor. When the motor speed drops below the specified amount, the switch opens, reducing the shunt field current and increasing the motor speed.

The speed range of the speed regulator is determined by the position of the contacts of S-107 and in part by the setting of R-114. The adjustment of the speed regulator is an involved process and should not be attempted unless the required test equipment is available. The proper method is outlined on page 49.

A noise filter (Z-104) is included in the circuit of S-107 to prevent interference in the ship's communications equipment.

Since the speed regulator switch employs two brushes and a pair of contacts, it will require maintenance.

WARNING: The speed regulator parts are not interchangeable on the two types of Motors; see the parts list.

NOTE: Very early speed regulators employed variable control R-115 instead of fixed resistor R-120. The use of this extra control is covered in the speed regulator adjustment procedure (see page 49).

5.3 EXCITER GENERATOR

The exciter generator for the 400-cycle Alternator is a simple self-excited shunt generator mounted on the end of the Alternator. This generator furnishes direct current at about 100 volts to the unregulated rotating alternator field through a variable resistor R-113. The adjustment of R-113 determines the alternator output voltage to a certain extent, and should not be tampered with without first reading the instructions given on page 50.

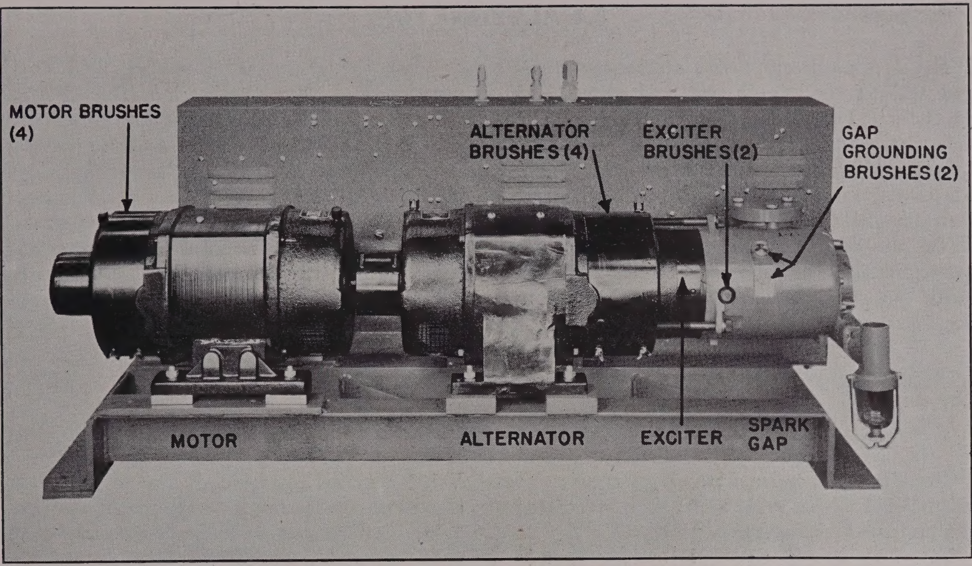

MOTOR BRUSHES (4)
ALTERNATOR BRUSHES (4)
EXCITER BRUSHES (2)
GAP GROUNDING BRUSHES (2)
MOTOR
ALTERNATOR
EXCITER
SPARK GAP

Fig. 54 — Motor-Alternator-Modulator with CRP-10212 Spark Gap.

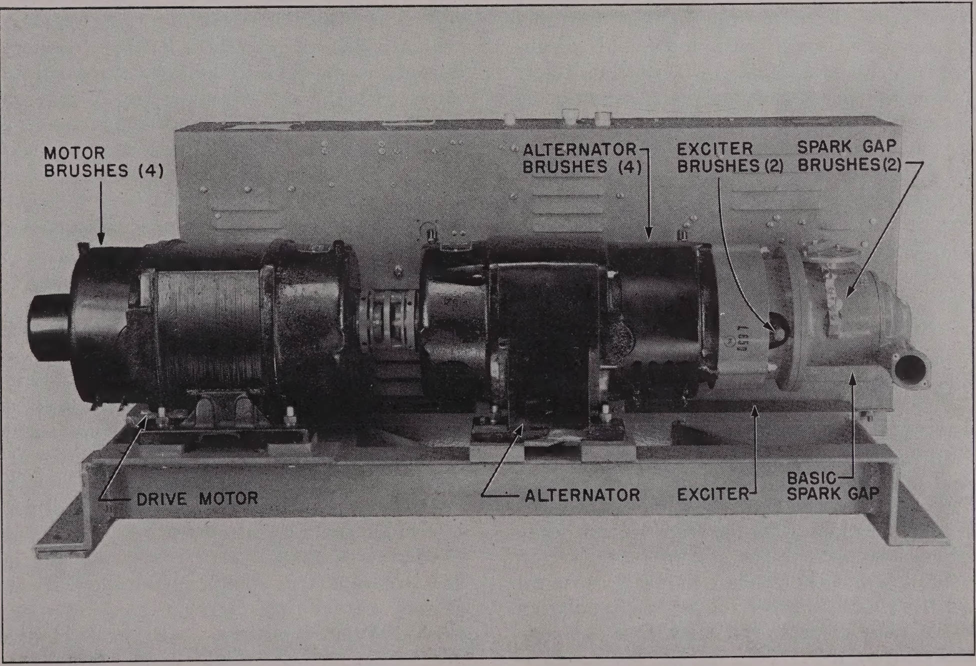

MOTOR BRUSHES (4)
ALTERNATOR BRUSHES (4)
EXCITER BRUSHES (2)
SPARK GAP BRUSHES (2)
DRIVE MOTOR
ALTERNATOR
EXCITER
BASIC SPARK GAP

Fig. 55 — Motor-Alternator-Modulator with CRP-10249 Basic Spark Gap.

5.4 ALTERNATOR

The Alternator employs a stationary armature and a rotor having two field coils. Field #2 is excited from the voltage regulator. The magnitude and duration of these pulses are controlled by the voltage regulator. Field #1 is energized by the exciter generator through field rheostat R-113. The two fields are additive, so that the increase in excitation of the regulated field #2 results in an increased voltage output from the Alternator.

When the generator is started, field #2 is open and receives no excitation. The Alternator output is held to approximately 105 volts by the adjustment of R-113. As the regulator tubes heat up and time-delay relay K-110 closes, field #2 is energized by the regulator and the Alternator delivers 115 volts at 400 cycles. Should the alternator load increase and the terminal voltage drop, field #2 automatically receives more excitation, raising the voltage to 115 volts.

5.5 ELECTRONIC VOLTAGE REGULATOR

The alternator voltage regulator consists of tubes V-101, V-102, V-103, and their associated components (see Fig. 56).

The function of this regulator is to sample the alternator output voltage and to apply a compensating current to the alternator's regulated field to compensate for improper output voltage.

The primary of T-104 is connected directly across the alternator output and furnishes filament power to all tubes and a.c. plate voltage to V-101 and V-102. V-102 operates solely as a half-wave rectifier, the plate current being determined by the plate voltage (alternator output). The plate current of V-102 is filtered by R-118 and C-102 and develops a positive voltage drop proportional to the alternator output voltage across the resistors R-118, R-117, and R-123. This positive excitation is applied to the grid of V-101 through the potentiometer R-117. The grid of V-101 is negatively biased 22½ volts by battery B-106. As the plate voltage of V-101 is alternating current, the plate current will consist of alternate half-cycle pulses, the magnitude of which is determined by the plate voltage (alternator output) and the drop across R-117, R-118, and R-123.

The plate current of V-101 passes through R-119, developing a negative-voltage drop which is applied to the grid of the thyratron V-103. Across the resistor R-119 is capacitor C-101, which charges during each pulse of V-101 plate current, and discharges exponentially through R-119 during the non-conducting half cycle. This means that the grid of V-103 remains negative during most of the alternator cycle, but is continually varying, being highly negative during the period V-101 conducts and dropping rapidly during the period V-101 is non-conducting. The voltage drop across R-119 and C-101, and the discharge time, are directly controlled by the alternator output voltage.

Tube V-103 is a grid-control thyratron acting as an electronic relay. Its plate voltage, which is derived directly from the alternator output, is of opposite phase (connected in series with the alternator output) to that on V-101, so it is negative when V-101 is conducting and positive when V-101 is non-conducting. As the plate of V-103 becomes positive, its grid voltage, which is negative due to the charge in C-101, rapidly changes toward zero due to the leak-off through R-119.

If the alternator output voltage is high, C-101 will charge highly negative and will not discharge through R-119 sufficiently to cause ionization of thyratron V-103 until late in the cycle. Since the thyratron conducts only during the time when its plate is positive and its grid is below the critical value, plate current will flow only during a very short interval. Thus the average excitation to the field is reduced and the alternator output voltage lowered. Should the alternator output voltage be too low, C-101 will charge to a lesser degree and will discharge completely through R-119 at some earlier time during the period when the V-103 plate is positive. As the grid of V-103 approaches zero potential, the grid loses control and a heavy plate current flows during the

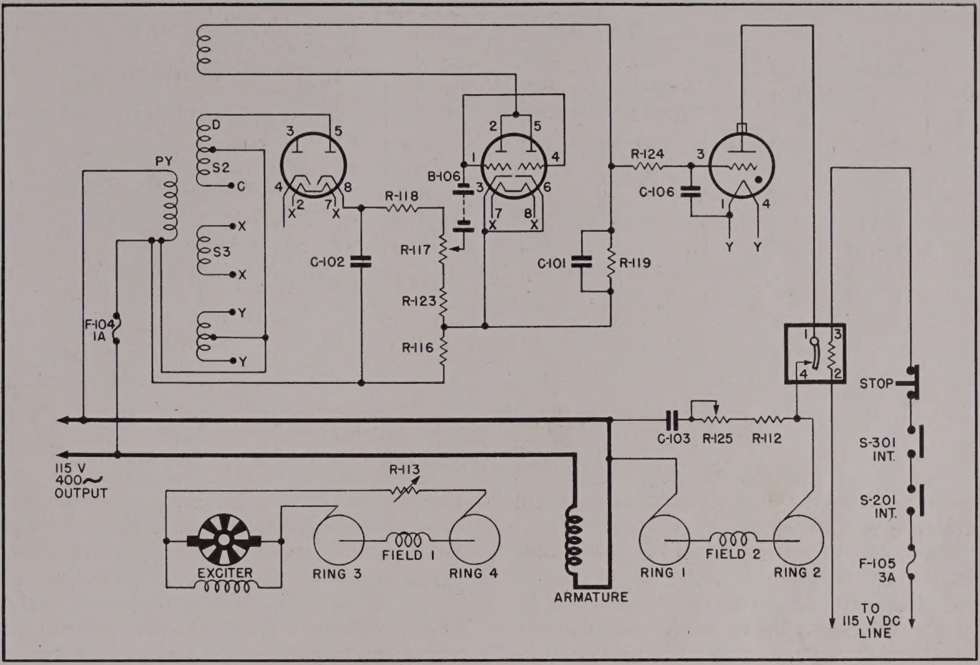

PY
D
S2
C
X
S3
X
Y
Y
F-104
1A
3
5
4
8
2
7
X
X
R-118
C-102
B-106
2
5
1
4
3
6
7
8
X
X
R-117
R-123
R-116
C-101
R-119
R-124
3
C-106
1
4
Y
Y
1
3
4
2
STOP
C-103
R-125
R-112
S-301
INT.
S-201
INT.
F-105
3A
TO
115 V DC
LINE
115 V
400~
OUTPUT
R-113
EXCITER
RING 3
FIELD 1
RING 4
ARMATURE
RING 1
FIELD 2
RING 2

Fig. 56 — Electronic Voltage Regulator (using V-102, V-101, and V-103).

remainder of the half cycle, increasing the average excitation to the alternator #2 field and thus raising the output voltage.

It can be seen that the duration of this pulse (hence the field excitation) is dependent on the time required for C-101 to discharge to the critical grid voltage of V-103. If the alternator voltage is low, this condenser will discharge sooner, allowing a greater field excitation; while a high output voltage will cause a longer discharge period and a smaller amount of excitation.

These half-cycle excitation pulses are filtered by the action of R-125, C-103 and the field; thus the actual correcting field current is a moderately filtered direct current. This is necessary to prevent distortions of the alternator waveform.

Thermal time-delay relay K-110 protects the thyratron and prevents erratic regulation during the warming-up period. This relay closes in about 45 seconds.

Control R-117 adjusts the excitation to V-101 and determines the output voltage of the Alternator.

NOTE: A fixed resistor R-112 was used in place of R-125 in early equipments.

The voltage regulator is properly adjusted at the factory and, since the adjustment is virtually independent of variations in the tubes, should not require readjustment.

Adjustment of the voltage regulator is a tedious operation. It should not be attempted before carefully reading "Voltage Regulator" under Maintenance and Service, page 50.

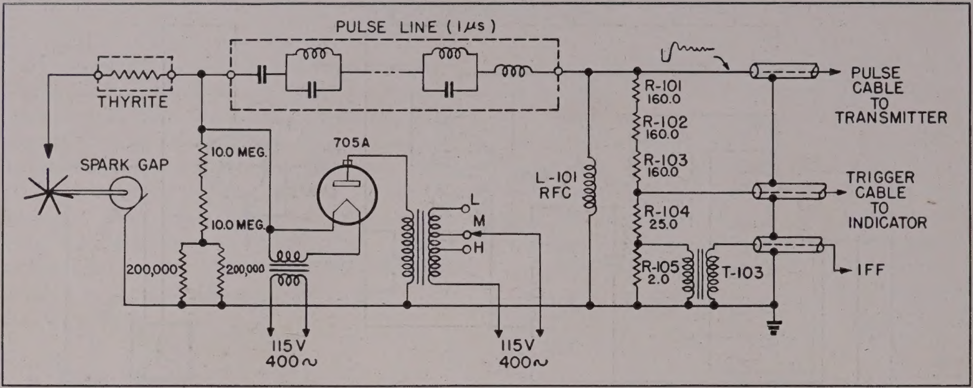

PULSE LINE (1μs)
THYRITE
SPARK GAP
10.0 MEG.
10.0 MEG.
200,000
200,000
705A
L
M
H
115V
400~
115V
400~
L-101
RFC
R-101
160.0
R-102
160.0
R-103
160.0
R-104
25.0
R-105
2.0
T-103
PULSE
CABLE
TO
TRANSMITTER
TRIGGER
CABLE
TO
INDICATOR
IFF

Fig. 57 — Motor-Alternator-Modulator: spark gap and modulator.

5.6 MODULATOR

The function of the Modulator is to develop a medium-voltage square-wave pulse of one-microsecond duration to key the magnetron oscillator (see Fig. 59).

Voltage from the Alternator is stepped up to about 9.5 kv., by transformer T-105, and this voltage is rectified by a half-wave rectifier. The rectified energy is used to charge a pulse line (artificial transmission line) (see Fig. 57).

The pulse line is designed to discharge with a practically uniform current until completely discharged, when terminated in its characteristic impedance. This line is discharged by a rotary spark gap 400 times per second. Since the discharge time is only one microsecond, the relatively slow-moving gap virtually stands still during the arcing period, thus maintaining a constant impedance in the discharge circuit.

Connected in series with the pulse line and spark gap are the primary of the pulse transformer T-302A and the non-linear Thyrite resistor. When the gap fires, the discharge current passes through the primary of the pulse transformer. The voltage developed across the primary is stepped up and keys the magnetron oscillator V-311. As the pulse line discharges with a uniform current for one microsecond, the voltage developed across the pulse transformer primary is a one-microsecond square wave.

Owing to the reactive component in the load circuit of the pulse line, a rapidly damped wave train ("tails") follows the main pulse. The first few pulses are of sufficient amplitude to key the oscillator, causing extra delayed oscillations. These delayed oscillations, if allowed to persist, would cause false markers to appear on the PPI and would tend to block the Receiver, thereby making it momentarily inoperative. Consequently, several cumulative means are provided for damping out these tails.

The principal means is a non-linear Thyrite resistor connected in the discharge circuit. The characteristic of this resistor is such that its resistance varies *inversely* as a function of the voltage across it. Hence the high-amplitude main pulse is attenuated only slightly because the resistance is low; while the lower amplitude tails are greatly attenuated because the Thyrite resistance is then high.

The tails are further damped by a so-called tail-clipper choke L-101 connected across the

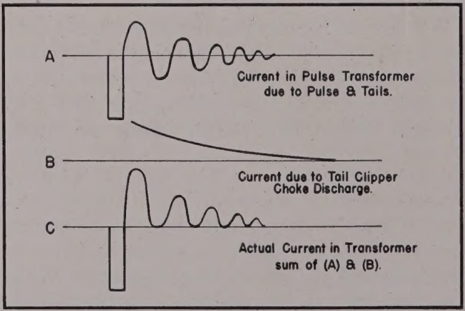

A
Current in Pulse Transformer due to Pulse & Tails.
B
Current due to Tail Clipper Choke Discharge.
C
Actual Current in Transformer sum of (A) & (B).

Fig. 58 — Tail-Clipping Action.

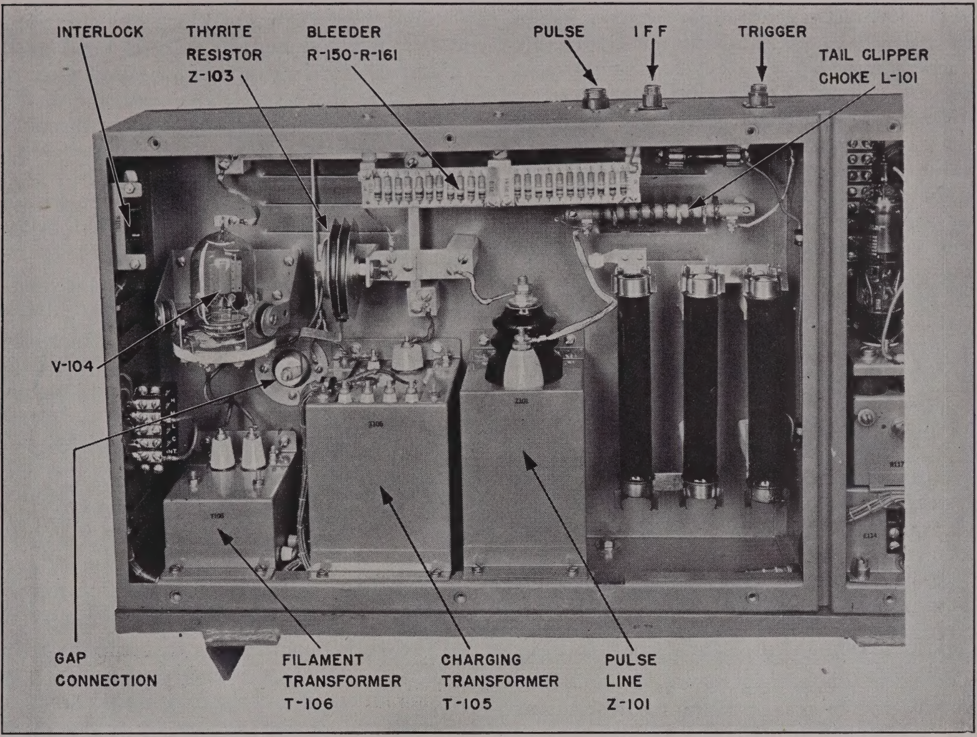


Fig. 59 — Motor-Alternator-Modulator: modulator compartment open.

primary of the pulse transformer. This choke passes a small amount of current during the pulsing period, storing energy in the form of magnetic lines of force. When the pulse stops, this magnetic field collapses, generating a voltage which tends to cause current to flow in the transformer primary in a direction opposite to that of the pulse.

The current in the transformer resulting from the tails is added to the current caused by the discharge of the tail-clipper choke, and the tails are thereby raised into the positive region (see Fig. 58). After several cycles and at about the same time that the choke discharges, the tails are completely damped out by the action of the resistors across the primary (R-101 through R-105). Since only negative pulses (those below the reference line in Fig. 58) can cause the magnetron anode to go positive with respect to the cathode (i.e., to oscillate), the choke causes the anode to go negative while the tails are present, thus preventing oscillation of the magnetron.

Finally, the tails are further suppressed by biasing the magnetron immediately after the pulse. This method is covered on page 86 under "Pulse Modulation."

In actual operation, 115-volt a.c. 400-cycle power from the Alternator is applied to the primary of transformer T-105. The secondary delivers about 9.5 kv. to the diode rectifier V-104. When the plate of the diode goes positive as a result of secondary polarity (positive half-cycle), the tube conducts and the pulse line Z-101 begins to charge, the circuit being completed through L-101. At the peak of the positive half-cycle the pulse line is charged to maximum and maintains its charge while the secondary voltage is decreasing to zero, because the line cannot discharge back through the blocking diode.

For the same reason the pulse line retains its charge during the negative half-cycle until discharged by the gap. At some instant during the negative half-cycle, the spark gap electrodes come into proper firing position and thus provide a low-resistance path for the discharge of the pulse line. (As the diode is non-conducting during the negative half-cycle, the gap does not short-circuit the charging transformer.

Owing to the characteristics of the pulse line, the discharge current reaches its peak value almost instantaneously, remains constant for one microsecond, then suddenly drops to zero. As this discharge current passes through the primary of the pulse transformer, the voltage drop across the primary is a one-microsecond square-wave voltage. This potential is stepped up in the pulse transformer T-302A to about 18 kv., where it is used to key the magnetron.

In an ideally terminated pulse line the voltage developed across the termination (load) would be only one-half the terminal voltage of the pulse line before discharge. Owing to the losses in the spark gap and Thyrite resistor, the voltage developed across the pulse transformer is on the order of 4.5 kv.

Connected across the primary of the pulse transformer is a series circuit composed of resistors R-101 through R-105 and the primary of transformer T-103. In addition to affording a damping action, this circuit provides a low-potential sample of the pulse for synchronizing the Indicator and triggering the IFF. The small transformer T-103 inverts the IFF trigger to make available a positive IFF trigger voltage.

Since the pulse line is charged by a rectified d.c. source and remains fully charged until discharged by the gap, it may be discharged at any time. To prevent short circuiting of the charging source, however, the synchronous rotary gap is set to fire during the negative half cycle; i.e., when the plate of V-104 is negative. Since the gap may be set to fire within wide limits during the negative half cycle, the phasing is not critical.

The spark gap consists of seven radial rotating tungsten electrodes and a single adjustable fixed electrode. The gap is rotated by the alternator shaft through a flexible coupling. The fixed electrode connects to the pulse line through the Thyrite resistor, while the rotating electrodes are grounded by a brush system.

NOTE: Two types of gaps are currently in use on SO-1 Equipments: early-type gaps CRP-10212 and later-type "basic gaps" CRP-10249. Early-type gaps are no longer being made, and when all such gaps now on equipments or in spares have been worn out, they will be replaced with basic gaps.

The spark gap electrodes are cooled by a fan built into the gap assembly, the blades of which form a part of the rotating assembly.

Harmful gaseous by-products of the spark gap are carried away through a flexible duct connected to the gap exhaust manifold.

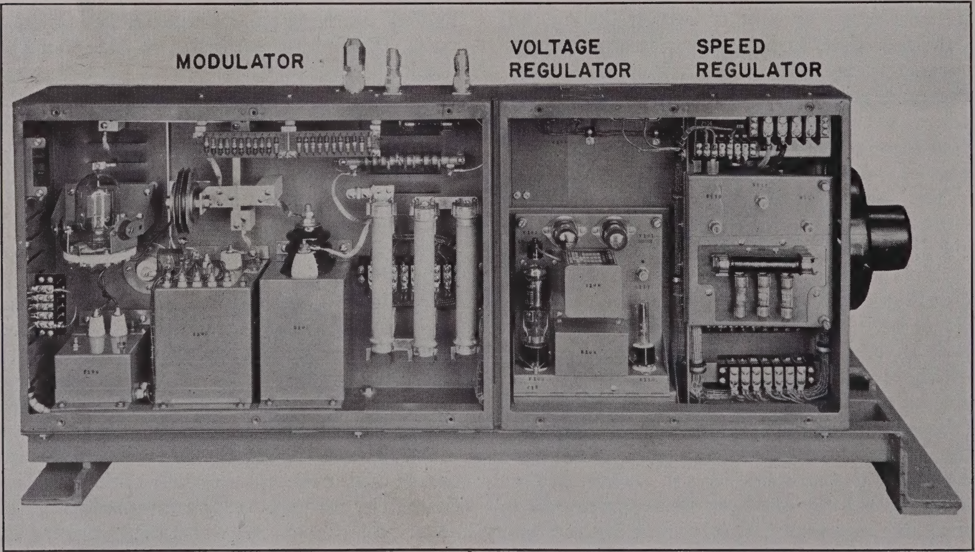


Fig. 60 — Motor-Alternator-Modulator: modulator and voltage regulator compartments open.

Section 6—Transmitter

6.0 GENERAL

The Transmitter-Receiver, as the name indicates, combines two units in a single case for transmitting and receiving r.f. energy. The Transmitter comprises a high-voltage pulse transformer, a magnetron oscillator, and a fixed-tuned r.f. system which includes a TR box (duplexing cavity) and a crystal mixer for the Receiver. A blower motor is included for cooling. (The Receiver is described separately in Sec. 7.)

The Transmitter-Receiver is usually installed on deck at the base of the mast. The unit is therefore enclosed in a waterproof package. All cables enter through watertight stuffing tubes, and the waveguide is coupled to the unit through a watertight Plexiglas window. The package is kept moisture-free by two silica-gel dehydrator plugs within the unit (see Fig. 65).

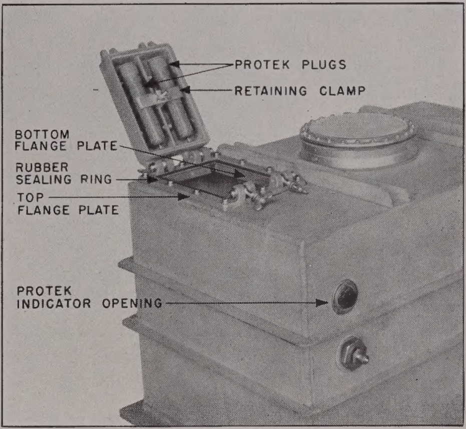

PROTEK PLUGS
RETAINING CLAMP
BOTTOM FLANGE PLATE
RUBBER SEALING RING
TOP FLANGE PLATE
PROTEK INDICATOR OPENING

Fig. 61 — Access Door.

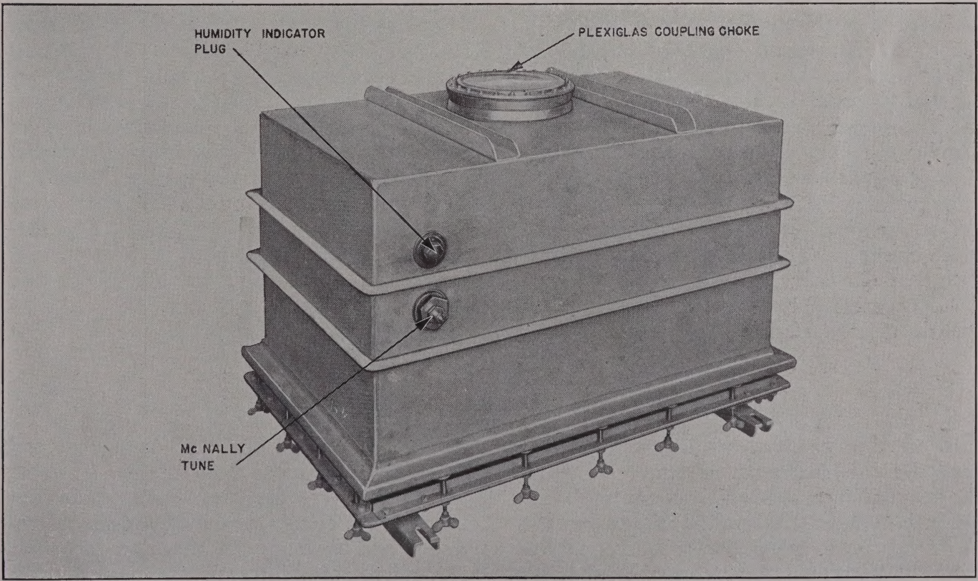

HUMIDITY INDICATOR PLUG
PLEXIGLAS COUPLING CHOKE
Mc NALLY TUNE

Fig. 62 — Transmitter-Receiver Unit.

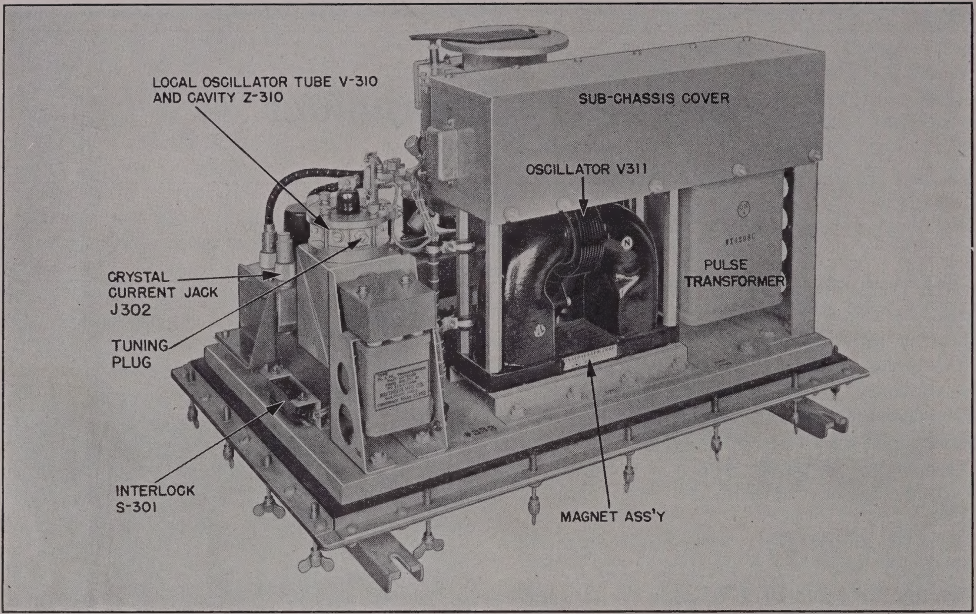


Fig. 63.— Transmitter-Receiver (cover removed): magnetron side.

6.1 PULSE TRANSFORMER

Refer to Fig. 64.

The pulse-forming line in the Modulator is designed to operate into a 50-ohm load. This line generates a pulse of approximately 4.5 kv. which is delivered to the Transmitter through a 50-ohm coaxial cable. Pulse-transformer T-302A, which has a turns ratio of 4-to-1, matches the 50-ohm line to the 800-ohm magnetron and at the same time increases the pulse voltage to approximately 18 kv.

Two identical secondary windings are provided on the pulse transformer, and phasing is such that a negative pulse in the primary produces negative pulses of equal amplitude in each secondary. Both secondaries of T-302A are thus brought up to the same potential, allowing filament transformer T-302B to be placed at the ground end of the pulse transformer windings and heating the magnetron filament through the two pulse transformer windings. Capacitors C-342 and C-343 act as high-frequency by-pass condensers, in effect connecting the secondary windings in parallel at the high frequencies comprising the square-wave pulse, but blocking the 400-cycle current from filament transformer T-302B. The filament transformer is included in the same case with the pulse transformer, the whole case being oil-filled.

6.2 PULSE MODULATION

In order to generate microwave energy, a potential difference must be developed across the magnetron cathode and anode (plate). The anode is connected to ground; the cathode is made negative by connection to the secondaries of the pulse transformer. Thus the anode remains positive with respect to the cathode during the period of the one-microsecond pulse.

Consequently the magnetron sends out trains of r.f. energy persisting for one microsecond and occurring 400 times per second at 2500-microsecond intervals.

In detail, the circuit functions as follows:

The positive end of the pulse transformer secondary is connected to ground through capacitor C-345, which is shunted by a bank of resistors R-336—R-338 and R-342—R-346. Capacitor C-345 provides a low-impedance path to ground for the one-microsecond pulse, thus completing the current path through the pulse transformer secondaries and the magnetron. During the pulse, capacitor C-345 accumulates a small charge, which discharges through resistors R-336—R-338 and R-342—R-346 during the quiescent period of the pulse. This biases the magnetron cathode positive with respect to the plate, preventing oscillation on minor pulses ("tails") which follow the main pulse.

A d.c. milliammeter connected from pin jack J-305 to ground provides a relative indication of the average magnetron current, the normal indication being 6–8 ma. as measured on a 0–10 milliammeter. On early-type Transmitters this pin jack is located on the rear of the shield covering the magnetron and pulse transformer; on later Transmitters it is placed on the local oscillator end of the shield.

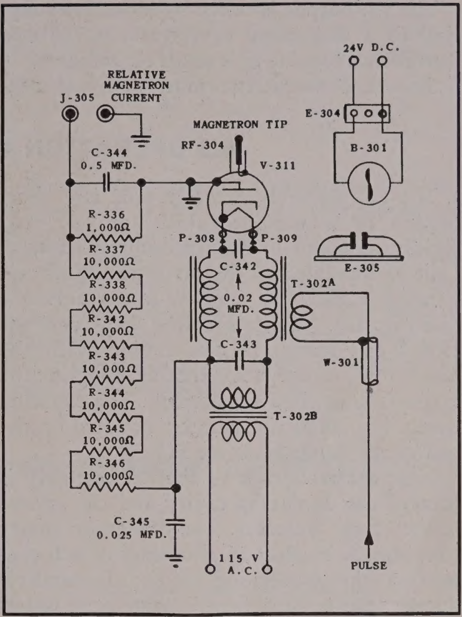

24V D.C.
RELATIVE MAGNETRON CURRENT
J-305
E-304
MAGNETRON TIP
RF-304
V-311
B-301
C-344 0.5 MFD.
R-336 1,000Ω
R-337 10,000Ω
R-338 10,000Ω
R-342 10,000Ω
R-343 10,000Ω
R-344 10,000Ω
R-345 10,000Ω
R-346 10,000Ω
P-308
P-309
C-342 0.02 MFD.
E-305
T-302A
C-343
W-301
T-302B
C-345 0.025 MFD.
115 V A.C.
PULSE

FIG. 64 — MAGNETRON OSCILLATOR.

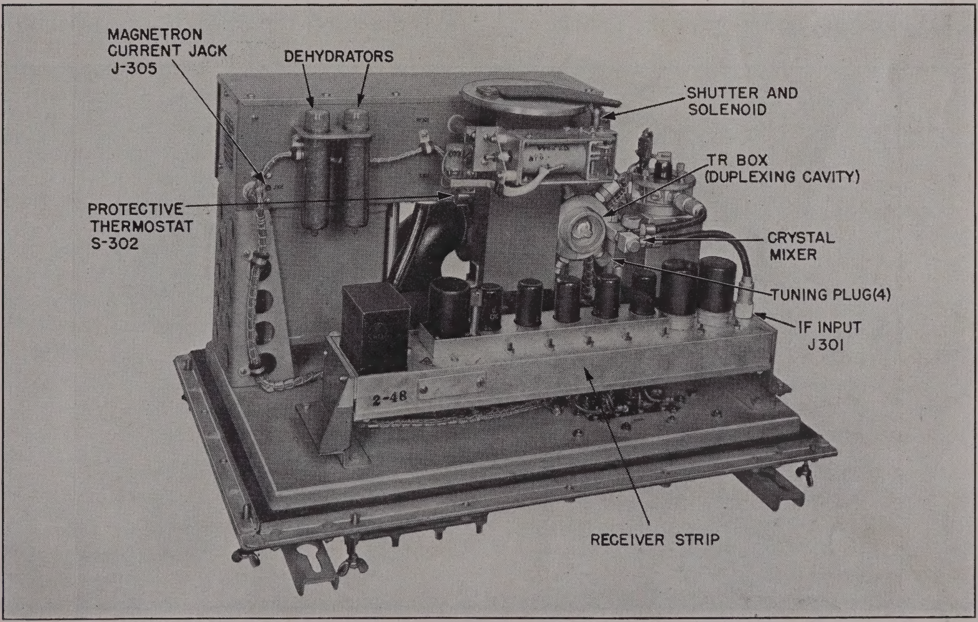

MAGNETRON CURRENT JACK J-305
DEHYDRATORS
SHUTTER AND SOLENOID
TR BOX (DUPLEXING CAVITY)
PROTECTIVE THERMOSTAT S-302
CRYSTAL MIXER
TUNING PLUG(4)
IF INPUT J301
2-48
RECEIVER STRIP

FIG. 65 — TRANSMITTER-RECEIVER (COVER REMOVED): RECEIVER SIDE.

The r.f. output is taken by inductive coupling to a magnetron cavity and is radiated into the waveguide by a small tip radiator.

Since the magnetron must dissipate considerable heat, a small 115-volt d.c. blower is provided for cooling. This blower operates at high speed and has a life expectancy of 1000 hours.

6.3 OPERATION OF THE R.F. SYSTEM

The r.f. assembly actually used is a short section of waveguide (closed at one end) rigidly mounted in the Transmitter-Receiver Unit and coupled to the main waveguide run through a Plexiglas window in the unit case (see Fig. 62). A short coupling sleeve near the closed end forms, in conjunction with the anode lead, a short coaxial cable, coupling the magnetron to the r.f. assembly. The coupling device is a small tip radiator mounted on the end of the anode lead (see Fig. 30).

Near the mid-point of the r.f. assembly is located the duplexing cavity and the crystal mixer of the Receiver. The duplexing cavity (TR box) is in effect an electronic switch connecting the waveguide to the Transmitter during transmission (at the same time isolating the Receiver from the waveguide), and connecting the waveguide to the Receiver during reception.

At the open end of the r.f. assembly is a protective shutter. This shutter is held open by a solenoid during operation of the equipment, but remains closed at all other times. This device prevents damage to the crystal mixer from excessive microwave energy from other nearby transmitters when the equipment is idle. During operation of the equipment the crystal is protected by the duplexing cavity and tube.

The r.f. assembly is coupled to the waveguide run by the Plexiglas-covered coupling choke mounted on the unit case. This coupler contains the necessary iris and choke to provide efficient transfer of energy from the r.f. assembly through the Plexiglas window to the main waveguide run.

Functionally the r.f. system operates as follows: During transmission, energy is conducted from the magnetron by a short coaxial line and is radiated from the tip into the waveguide. The dimensions and positions of the tip radiator and waveguide plug are such that the coupling coaxial line is properly terminated, and maximum energy is transferred from the magnetron to the waveguide.

As the energy travels up the r.f. assembly, a

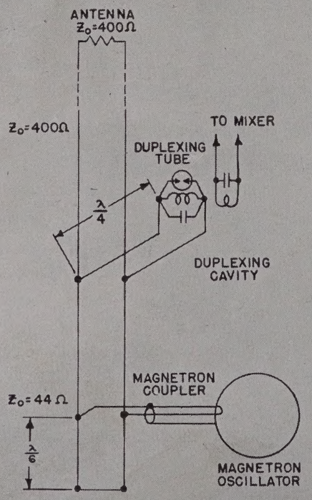

ANTENNA
Z_0=400Ω
Z_0=400Ω
TO MIXER
DUPLEXING TUBE
$\frac{\lambda}{4}$
DUPLEXING CAVITY
MAGNETRON COUPLER
Z_0= 44 Ω
$\frac{\lambda}{6}$
MAGNETRON OSCILLATOR

Fig. 66A — Low-Frequency Analogy of R.F. System.

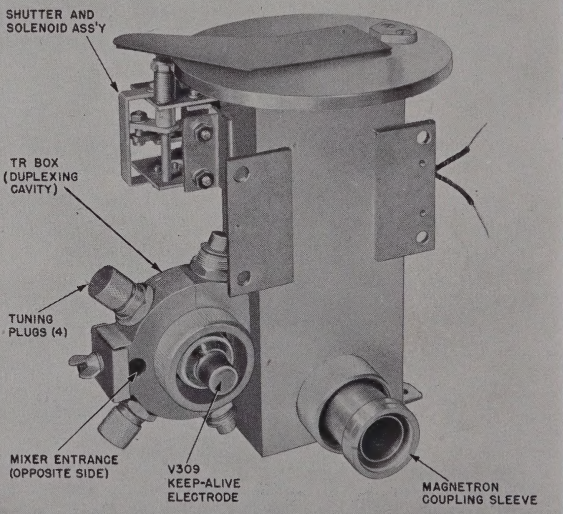

SHUTTER AND SOLENOID ASS'Y
TR BOX (DUPLEXING CAVITY)
TUNING PLUGS (4)
MIXER ENTRANCE (OPPOSITE SIDE)
V309 KEEP-ALIVE ELECTRODE
MAGNETRON COUPLING SLEEVE

Fig. 66B — R.F. Assembly.

small portion of it passes through the slot in the edge of the waveguide and enters the duplexing cavity. Since the cavity is tuned to the frequency of the Transmitter, maximum voltage appears across the lips of the cavity. Connected across these lips is a gaseous duplexing cavity which ionizes when the cavity is excited. This action virtually short-circuits the cavity. As the receiver mixer is coupled to the cavity, the amount of energy entering the mixer is limited to a safe value. To facilitate rapid ionization a keep-alive electrode is provided near one of the tube elements. This electrode is energized from a high-voltage secondary of transformer T-303, thus keeping the tube in partial ionization at all times.

During transmission the duplexing cavity limits the energy entering the cavity without altering the characteristics of the waveguide. After passing the cavity, the microwave energy passes through the coupling choke, enters the main waveguide run, and is finally radiated by the Antenna.

During reception, the duplexing cavity deionizes and in effect closes the waveguide below the cavity coupling slot. As the echoes return from the targets they pass down the waveguide, through the coupling choke, and into the duplexing cavity. Since the mixer is coupled to the duplexing cavity, almost all the returned energy enters the Receiver. (The theory is discussed on page 90.)

6.4 THEORY OF WAVEGUIDES AND RESONANT CAVITIES

The waveguide is a special form of transmission line adapted to the transmission of microwave energy with minimum attenuation.

Since the mathematical analysis of the waveguide is a complex matter, it is best to compare waveguide operation to that of a simple two-wire transmission line, developing the physical characteristics from this viewpoint.

Consider a balanced two-wire transmission line consisting of conductors X_1 and X_2 (Fig. 67) energized at a wavelength comparable to the spacing between the conductors. If the two conductors are suspended in a plane parallel to a metal surface, they may be supported from this surface by metal rods, provided that the rods are one-quarter wavelength long. This is permissible because the quarter-wavelength rods present a high impedance to the line conductors and act as insulators. If the number of rods is increased until they touch, solid walls are formed from the conductors to the plane surface, thus forming a continuous channel (one-half of a waveguide). If the same procedure is followed on the other side of the two-wire line, a complete closed waveguide is formed. Dimension *B* (Fig. 67) is not critical since the magnetic flux cannot link this surface. Dimension *A is* critical and must be equal to at least one-half the wavelength for the frequency used. If Dimension *A* is greater than this, it merely means that the two conductors have been widened or increased in size, the supports remaining one-quarter wavelength long.

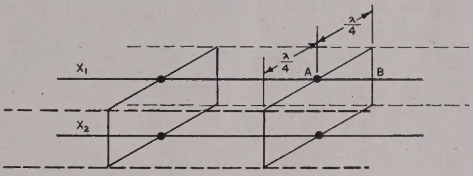


FIG. 67 — DEVELOPMENT OF WAVEGUIDE.

This multiple-rod design is cited merely to illustrate the theoretical development of the waveguide. Obviously it is not used in practice. The waveguides in common use are merely copper tubes of rectangular cross section, and they need not be mounted against a flat surface.

* * *

The cavity is a special form of parallel-resonant circuit adapted for use in the microwave region.

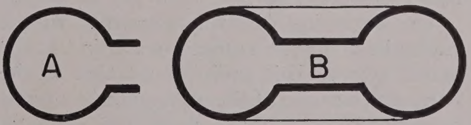


FIG. 68 — DEVELOPMENT OF CAVITY.

Consider a single-turn inductance (Fig. 68A). This is a conventional parallel-resonant circuit for high frequencies, the parallel capacitance being the sum of stray capacitances between the upper and lower halves of the single turn. However, a single-turn resonant circuit of this type is not practicable for use in the microwave region owing to its low Q. In order to increase the Q, other single turns of identical characteristics may be connnected in parallel with the original turn, thereby greatly reducing the resistance of the circuit. At the same time, of course, the inductance is decreased but the parallel capacitance is increased; consequently the frequency is kept substantially constant. If the turns are made to terminate on rings, a doughnut-shaped cavity is formed; and if the number of turns is increased until they touch, the walls of the cavity become solid (see Fig. 68B).

The cavities actually used in the Radar equipment are machined from solid metal, the walls forming an infinite number of parallel lines.

Obviously, the resonant frequency of a cavity may be changed by altering its dimensions, and tuning over narrow bands may be accomplished by plugs (which vary the inductive component) or by vanes (which vary the capacitive component). The duplexing cavity (TR box) used in the SO-1 r.f. system is tuned by means of four plugs. The local oscillator cavity used in the SO-1 Receiver is tuned over a relatively wide range by means of six vanes and is tuned over a narrow range by a single plug.

6.5 THEORY OF THE R.F. SYSTEM

This section shows how a simple theoretical waveguide is modified to conduct r.f. energy from the magnetron through a fixed-tuned waveguide and into a rotating radiating system in the Antenna.

Since the r.f. system contains many unfamiliar pieces of equipment, its theory of operation is best explained by a low-frequency analogy. The developed analogy is shown in an electrical equivalent diagram, Fig. 66A. The waveguide appears as a two-wire balanced non-resonant line short-circuited at one end. The duplexing cavity is shown as a high-Q resonant circuit, and the duplexing tube as a simple spark gap in shunt with the tuned circuit. The Antenna appears to the waveguide as a 400-ohm pure resistance. The magnetron tip radiator is not shown as such, the magnetron coaxial line being apparently connected directly across the two-wire transmission line near the shorted end.

The duplexing cavity is connected to the transmission line by a quarter-wave line. In the actual system, this cavity is coupled to the narrow dimension of the waveguide at a point one-quarter wavelength from the apparent two-wire line developed in Section 6.4. The impedance of the transmission line is zero at the short circuit, increasing to 400 ohms one-quarter wavelength farther along the line. Some intermediate point will offer 44 ohms impedance to a generator tied across it. Since the magnetron coaxial coupling cable has a characteristic impedance of 44 ohms, it is properly terminated when connected across the critical point, and maximum power is transferred. This point is approximately one-sixth wavelength from the short-circuited end.

The duplexing cavity, its associated duplexing tube, and the quarter-wave line are connected to a two-wire line a short distance above the magnetron connection. The distant end of the transmission line is terminated in its characteristic impedance (400 ohms).

During transmission, energy from the magnetron is delivered to the transmission line. This energy excites the tuned circuit (duplexing cavity) through the quarter-wave line, causing the spark gap (duplexing tube) to ionize. When the gap ionizes, the tuned circuit is virtually short-circuited, reflecting a very high impedance across the two-wire line one-quarter wavelength away. Since the relatively low-impedance transmission line is shunted by this high impedance, its characteristics are unaltered and little energy enters the tuned circuit; and since the Receiver is inductively coupled to the tuned circuit very little energy enters the crystal mixer and Receiver.

Because the only appreciable load on the two-wire line is resistive, no standing waves are present, and almost all the microwave energy enters the antenna system.

During reception, energy returning down the transmission line encounters slightly different terminating conditions from those encountered during transmission. The terminal

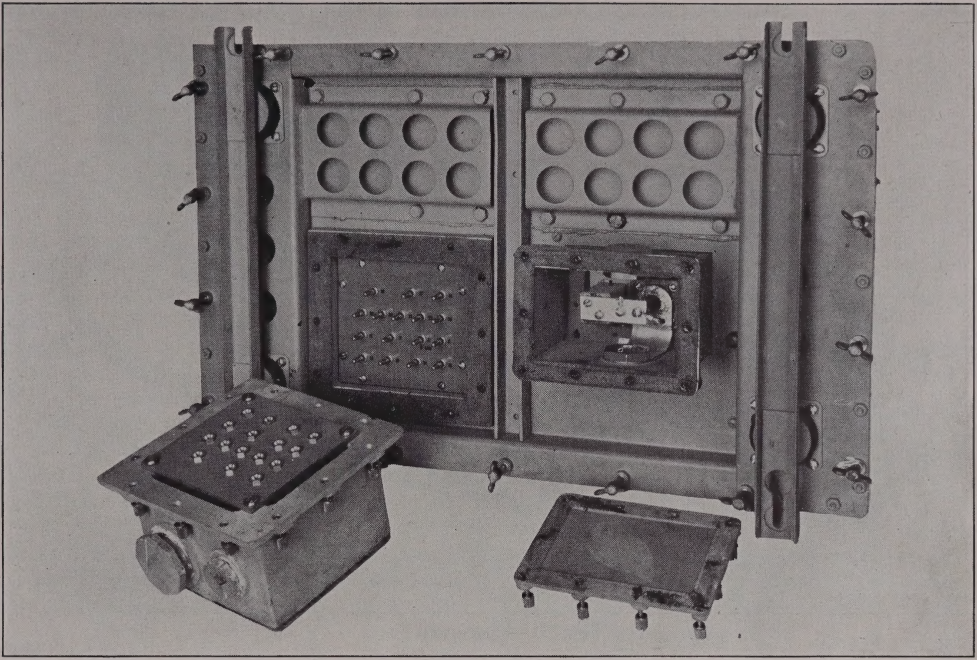


Fig. 69 — Transmitter-Receiver: underside.

end (magnetron end) apparently does not properly terminate the transmission line, and standing waves are present.

During the receiving period the duplexing tube deionizes and the cavity again becomes a high-Q parallel-resonant circuit. It would reflect almost a short circuit across the transmission line, but owing to the loading of the cavity by the mixer in the Receiver, the reflected impedance approaches the characteristic impedance of the line (400 ohms). Thus most of the energy from the returning signal enters the duplexing cavity and Receiver, but owing to a slight mismatch, some energy passes the cavity and enters the magnetron. This energy is reflected in the magnetron, producing a standing wave. Since the cavity is permanently fixed at a voltage loop during manufacture, virtually all the reflected energy enters the duplexing cavity and the Receiver. And since the transmission line from the Antenna to the duplexing cavity is terminated very nearly in its characteristic impedance, almost no standing waves are present in this section. However, in the section from the magnetron to the cavity the standing-wave ratio is quite high (see Fig. 66B).

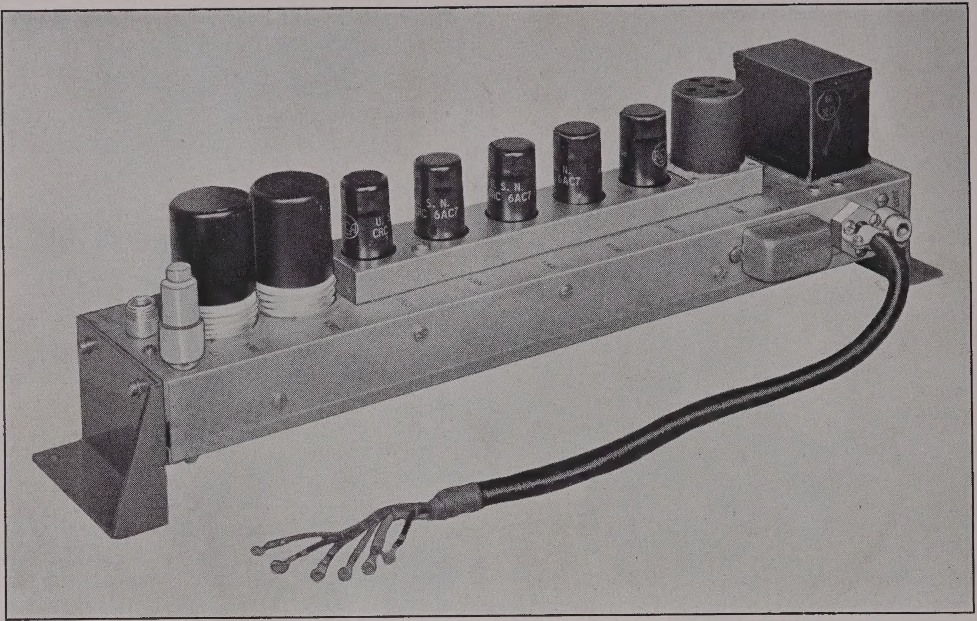

U. S. N.
CRC 6AC7
U. S. N.
CRC 6AC7
6AC7

Fig. 70 — Receiver Strip.

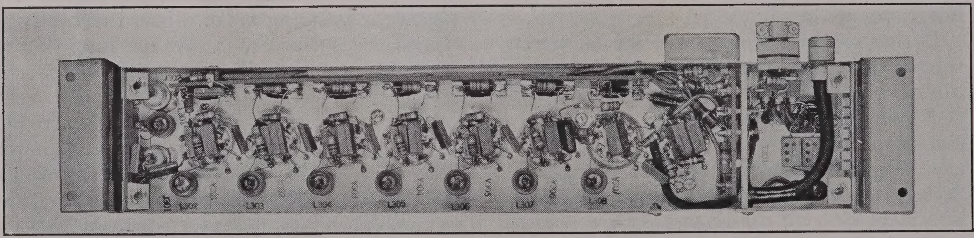

L302
L303
L304
L305
L306
L307
L308

Fig. 71 — Receiver Strip: underside.

Section 7 — Receiver

7.0 GENERAL

Receiver CRP-46ACA-1 is the only type used with Model SO-1 Radars. It is not readily replaceable with type CRP-46ACA (used on other SO-Series Equipments), owing to the different polarity of the video output.

Except for the input and output circuits, the Receiver follows the conventional superheterodyne design. It has a gain of approximately 120 db. and an i.f. bandwidth of 2 Mc.

The receiver chassis contains eight type-6AC7/1852 tubes, which serve as the intermediate frequency amplifier, demodulator (second detector), and video-limiter stages. The filament transformer is located at one end of the chassis.

The 707-B local oscillator tube is separately mounted on the main chassis of the Transmitter-Receiver, near the receiver chassis. The plate and bias-voltage supplies are located in the Rectifier Power Unit. Input and output connections are made by means of coaxial jack and plug connectors. The power cable is of the multi-conductor rubber-covered type, and connects (through an intermediate terminal strip) to the main terminal board beneath the Transmitter-Receiver.

7.1 LOCAL OSCILLATOR ADJUSTMENTS

In conventional superheterodyne fashion, the local oscillator, in conjunction with the crystal mixer, generates the intermediate frequency. This is a McNally tube, which is a velocity-modulated oscillator of the reflex Klystron type comprising a cathode, an accelerator grid, two cavity grids, and a repeller plate. The frequency of oscillation is chiefly determined by the dimensions and adjustments of the resonant cavity enclosing the cavity grids, but is also influenced by the potential of the repeller plate.

The tuning adjustments comprise a tuning plug and six rotatable vanes. All of these are pre-set at the factory, and will normally require no adjustment in the field except after replacement of the magnetron or the McNally tube. Adjustment of the plug and vanes is fully covered in Sec. 4.3 under "Tuning the Local Oscillator." The small frequency changes required during operation are made by varying the bias voltage on the repeller plate of the tube, through the adjustment of TUNE Control H (on the Indicator). Fig. 72 shows the oscillator circuit and the filtering provided to prevent interaction between the microwave circuits and the supply circuits.

Since the frequency of oscillation is determined in part by the repeller plate voltage, the

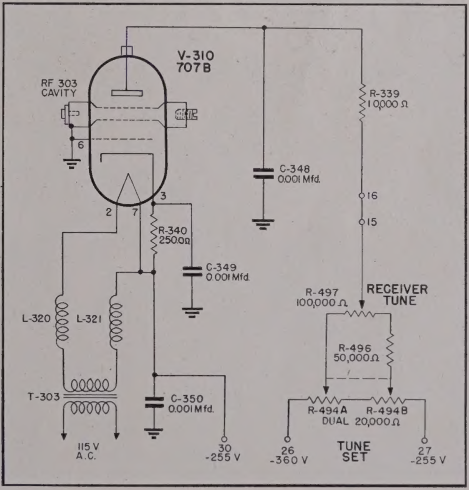


Fig. 72 — Receiver: local oscillator.

plate supply must be closely regulated. This is done by employing gaseous regulator tubes in the Rectifier Power Unit.

For smooth, stable operation of the local oscillator, the plug, vane, mixer coupling, and TUNE SET Control G (on the Indicator) must all be carefully adjusted. Detailed tuning procedures for normal operation are outlined on page 17, and plug and vane adjustments are outlined in Sec. 4.3.

7.2 LOCAL OSCILLATOR THEORY

In operation, the electrons are emitted by the cathode and are accelerated by the accelerator grid which is maintained positive with respect to the cathode. Actually, the accelerator grid and the cavity are grounded, and the cathode operates at negative potential with respect to ground. When the accelerated electrons reach the region of the first cavity grid (fin), some of them are collected by it and shock-excite the tuned cavity, but most of them pass through the grid. When the cavity is excited, the two grids assume opposite polarities since they are connected to opposite ends of the cavity. Should the first cavity grid be instantaneously negative, electrons approaching it will be affected by a weak repelling field and will lose velocity, while electrons leaving it will be accelerated since the repelling force acts in the same direction as the electron flow. At the same instant the second cavity grid will be positive and will accelerate electrons approaching it and decelerate electrons leaving it. In this way the electron stream is arranged in quanta or bunches of electrons. The velocity of electrons leaving the accelerator grid is so high that the relatively weak force exerted on them by the cavity grids changes their velocity only slightly and does not stop them or reverse their direction. As the bunched electrons pass through the second cavity grid, they approach a strong repeller field generated by the highly negative repeller plate. The electrons reverse their direction of travel and again approach the cavity grids. If the repeller potential is of the proper value, the velocity of the returning electrons

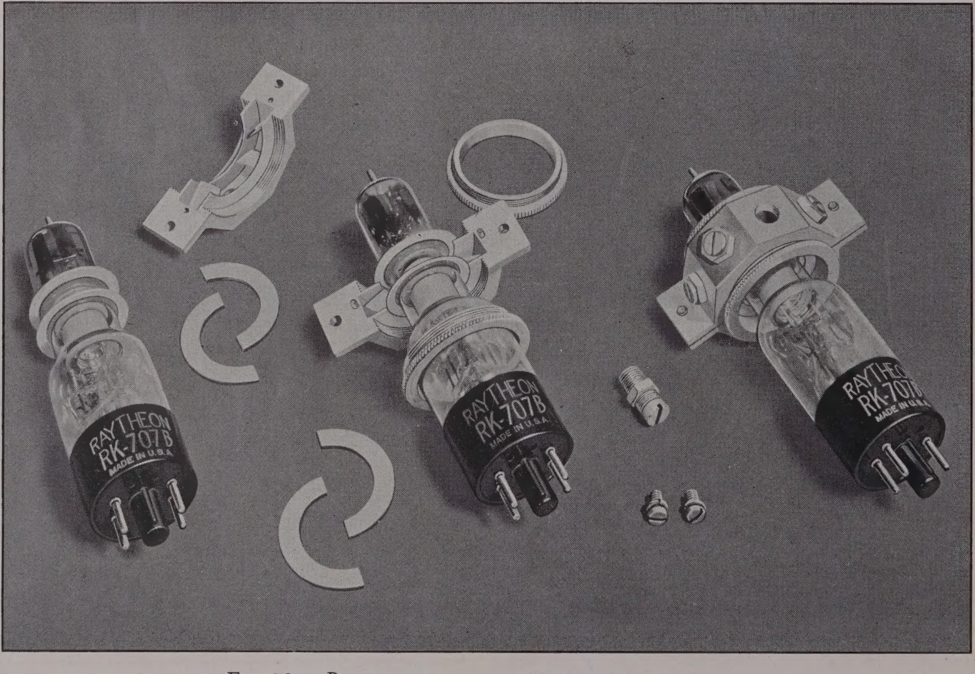


Fig. 73 — Receiver: local oscillator tube and cavity.

can be adjusted so that electron bunches pass through the cavity grids in phase with those going out, thus adding to the energy in the cavity and causing oscillation. Electrons not collected by the cavity grids are eventually collected by the accelerator grid. Owing to the mutual repulsion of electrons and the two-way electron flow, the bunches tend to break up and reduce the efficiency of the oscillator.

7.3 INPUT CIRCUIT AND CRYSTAL MIXER

The input circuit is basically a short resonant section of coaxial line short-circuited at one end. Incoming signals are introduced (from the duplexing cavity) into one end of this line, electromagnetic coupling being provided by means of a small transverse slot in the outer conductor inserted in the duplexing cavity. Output from the local oscillator is delivered to the receiver input circuit near the mid-point of the resonant line. A coaxial line couples the oscillator to the mixer, the coupling being inductive at the oscillator cavity and capacitive at the mixer.

The crystal is connected to the open end of the resonant line (see Fig. 74). The crystal output is filtered by a small capacitor formed by interposing mica washers between the crystal mounting and the outer conductor of the line. The crystal acts as a frequency converter and delivers the intermediate frequency of 30 Mc. across the mixer output. Terminals are provided at J-302 for measuring the rectified crystal current.

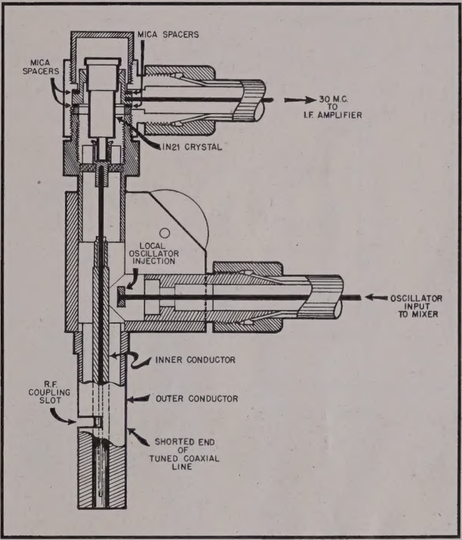

MICA SPACERS
MICA SPACERS
30 M.C. TO I.F. AMPLIFIER
IN21 CRYSTAL
LOCAL OSCILLATOR INJECTION
OSCILLATOR INPUT TO MIXER
INNER CONDUCTOR
R.F. COUPLING SLOT
OUTER CONDUCTOR
SHORTED END OF TUNED COAXIAL LINE

Fig. 74 — Cross Section of Mixer.

7.4 INTERMEDIATE FREQUENCY AMPLIFIER

This section of the Receiver consists of six stages of amplification operating on a frequency of 30 Mc. The gain per stage is approximately 20 db. Circuit constants and performances are practically identical in each stage, and the schematic diagram of the first and second i.f. stages (Fig. 75) represents any stage in the amplifier. Gain is controlled by varying the plate and screen voltage of the second stage.

The stages are impedance-coupled, and the tube and circuit capacitances are combined with an adjustable inductance to form a resonant circuit. The plate voltage is applied through a low resistance, which loads the resonant circuits and gives the necessary broad band-pass characteristic. The cathode-bias resistors are of lower value than usual because the tubes are operated at reduced plate and screen voltages. This lower bias value maintains the gain of each stage at a high level.

To eliminate regeneration throughout the amplifier, filtering is provided in the power and filament leads of each stage. Isolating resistors are used in the power leads, and chokes and by-pass capacitors in the filament leads. To prevent interference from the Transmitter from entering the i.f. amplifier, the separate leads are filtered at the entrance points.

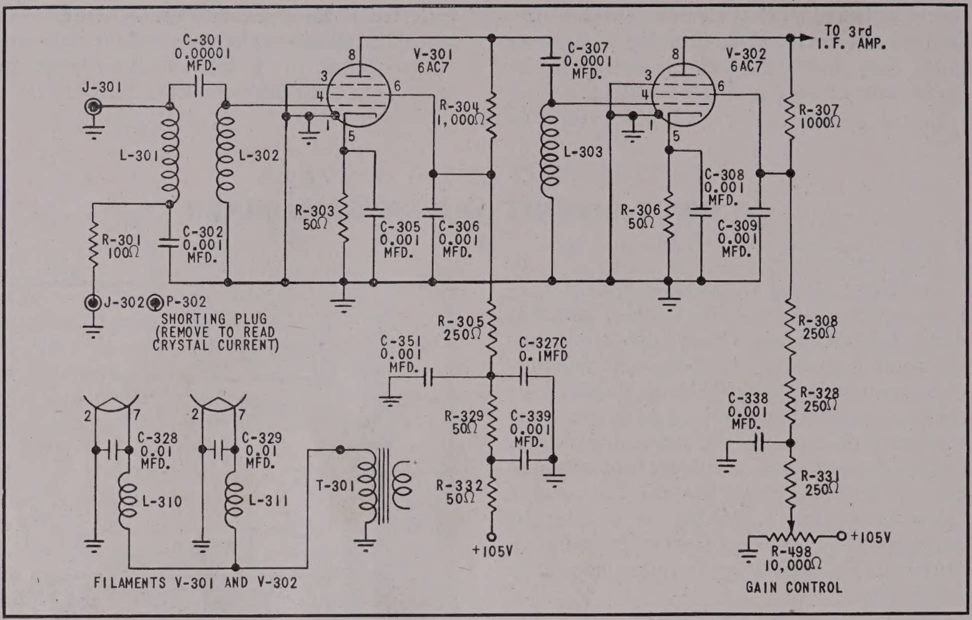

C-301
0.00001
MFD.
J-301
L-301
L-302
R-301
100Ω
C-302
0.001
MFD.
J-302
P-302
SHORTING PLUG
(REMOVE TO READ
CRYSTAL CURRENT)
V-301
6AC7
8
3
4
6
1
5
R-304
1,000Ω
R-303
50Ω
C-305
0.001
MFD.
C-306
0.001
MFD.
C-307
0.0001
MFD.
L-303
V-302
6AC7
TO 3rd
I.F. AMP.
R-307
1000Ω
C-308
0.001
MFD.
R-306
50Ω
C-309
0.001
MFD.
R-305
250Ω
C-351
0.001
MFD.
C-327C
0.1MFD
R-329
50Ω
C-339
0.001
MFD.
R-332
50Ω
+105V
2
7
C-328
0.01
MFD.
L-310
C-329
0.01
MFD.
L-311
T-301
FILAMENTS V-301 AND V-302
R-308
250Ω
R-328
250Ω
C-338
0.001
MFD.
R-331
250Ω
+105V
R-498
10,000Ω
GAIN CONTROL

Fig. 75 — Receiver: first and second I.F. stages.

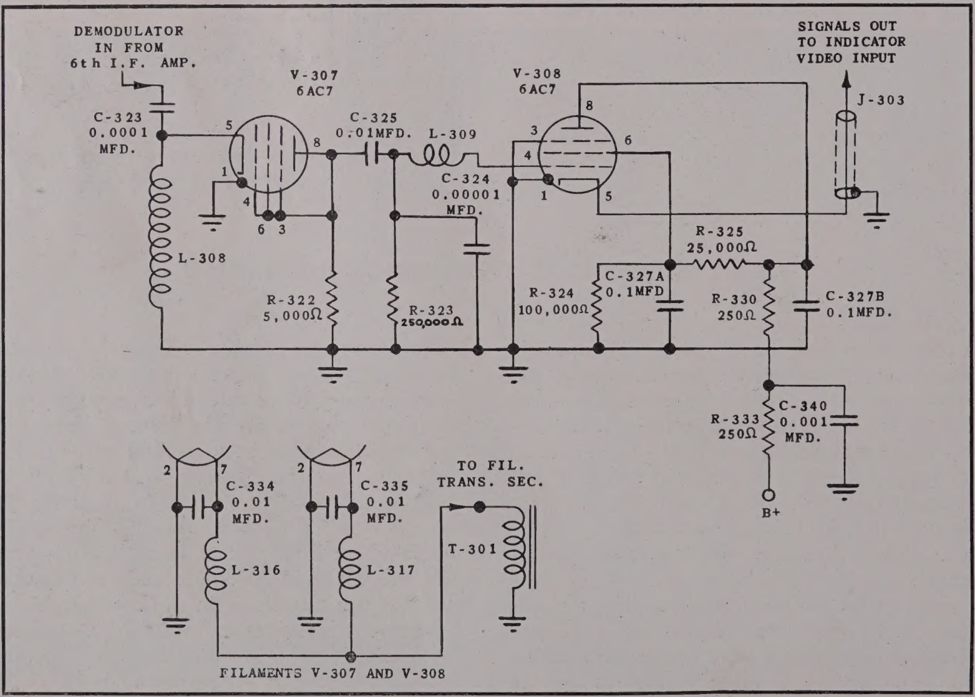

DEMODULATOR
IN FROM
6th I.F. AMP.
C-323
0.0001
MFD.
L-308
V-307
6AC7
5
8
1
4
6
3
C-325
0.01MFD.
L-309
C-324
0.00001
MFD.
R-322
5,000Ω
R-323
250,000Ω
V-308
6AC7
8
3
4
6
1
5
R-324
100,000Ω
C-327A
0.1MFD
R-325
25,000Ω
R-330
250Ω
C-327B
0.1MFD.
SIGNALS OUT
TO INDICATOR
VIDEO INPUT
J-303
R-333
250Ω
C-340
0.001
MFD.
B+
2
7
C-334
0.01
MFD.
L-316
C-335
0.01
MFD.
L-317
TO FIL.
TRANS. SEC.
T-301
FILAMENTS V-307 AND V-308

Fig. 76 — Receiver: second detector (demodulator) and video-limiter.

7.5 DEMODULATOR (SECOND DETECTOR) AND VIDEO-LIMITER

The demodulator tube is connected as a diode, the plate load circuit being filtered by a small inductor and capacitor to prevent 30-MC. energy from entering the video-limiter stage. The demodulator develops across the diode load resistor a negative pulse output which is capacitively coupled to the video-limiter.

The video-limiter is operated at near zero bias, and the plate current is limited to less than 10 ma. by reducing the screen voltage through a dropping resistor. The output cable of the Receiver terminates at the Indicator in a load of 100 ohms, which is the cathode resistor of the video-limiter stage. (See Fig. 76.)

Any pulse applied to the video-limiter grid of sufficient amplitude to drive the limiter to plate current cutoff will be reproduced as a negative signal of one volt across the 100-ohm limiter output circuit. Pulses of greater amplitude than this cannot produce output greater than one volt as the tube cuts off at one volt. Thus the limiting of strong signals results in a lower brilliance ratio on the PPI between weak and strong signals.

7.6 RECTIFIER POWER UNIT

This unit furnishes plate power for the Radar Receiver, including the local oscillator.

In early-type Rectifier Power Units all plate voltages, except those of the last i.f. amplifier and video-limiter, were closely regulated by the use of gaseous regulator tubes (see Fig. 78). As close regulation of i.f. amplifier voltages was found unnecessary, this regulation is omitted in later-type units. In both types, the voltages to the local oscillator are carefully regulated, since the frequency of the local oscillator is a function of the voltage between the various elements.

NOTE: Both types of Rectifier Power Units are directly interchangeable (see Fig. 79).

The power supply is so wired that its ground connection is 360 volts above the negative terminal. This is necessary because the local oscillator in the Receiver requires a regulated negative potential on its repeller plate. Non-regulated positive voltages of several values are also available for the receiver i.f. and video stages.

Operation and design of the rectifier, filters, and regulators are conventional.

Included in the unit are five fuses, a relay controlling the Modulator, and two line voltage dropping resistors (see Fig. 78). Underneath the hinged fuse and resistor panel are five terminal strips serving as a junction point for many of the interconnecting cables (see Fig. 81).

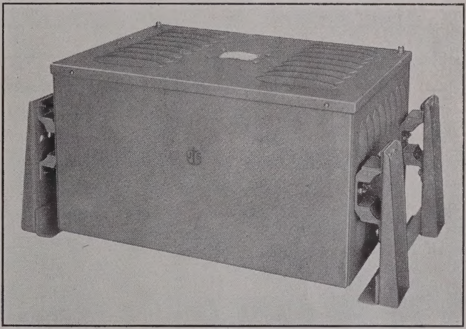


Fig. 77 — Rectifier Power Unit.

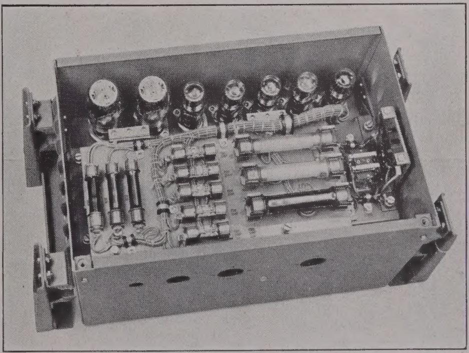


Fig. 78 — Rectifier Power Unit: chassis.

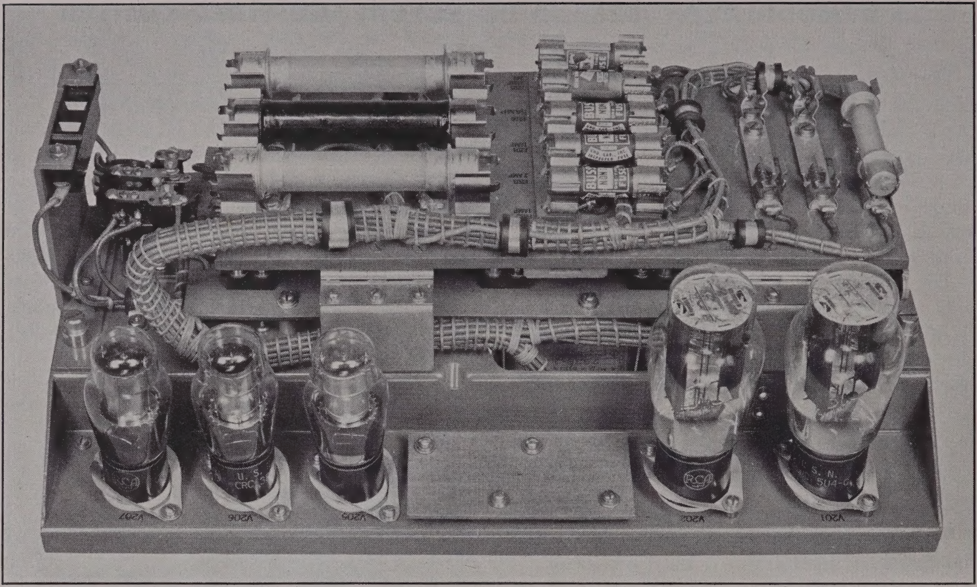

V207
V206
V205
V202
V201

Fig. 79 — Rectifier Power Unit: chassis (late type) r-212 and r-213 removed.

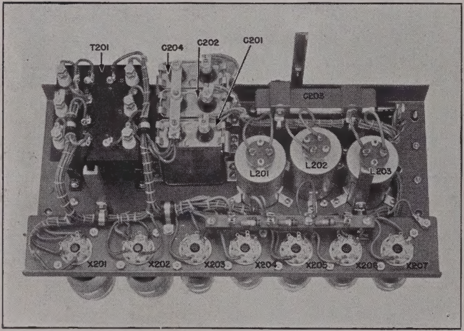
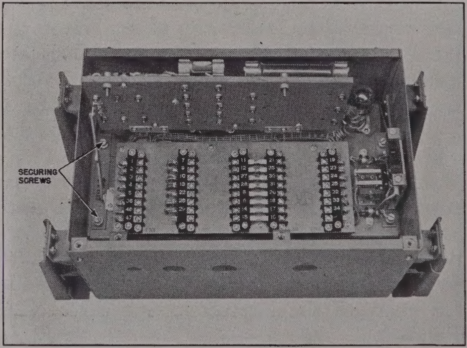

T201
C204
C202
C201
C203
L201
L202
L203
X201
X202
X203
X204
X205
X206
X207

Fig. 80 — Rectifier Power Unit: underside.

Fig. 81 — Rectifier Power Unit: terminal strips exposed.


SECURING SCREWS

Section 8—Indicator

8.0 GENERAL

The Plan Position Indicator (commonly called the Indicator) houses the PPI tube with its associated deflection coil drive mechanism, bearing dial, and video and sweep circuits. It also contains the principal operating controls, which are fully described in Sec. 3. A front view of the unit is shown in Fig. 82.

The screen of the PPI tube presents a map-like view of targets (reflecting objects) on the surface of the water surrounding the ship within range of the equipment. Targets appear as light streaks at right angles to a radius of the PPI. These streaks remain visible through the action of the long-persistence phosphorescent screen after the radial sweep has passed, thus permitting range and bearing to be read.

Each time the radial sweep comes around to a target point it retraces the target, and movement of the target is indicated in successive sweeps. Aircraft are easily identified in this manner. The experienced Radar operator can quickly determine the general nature of a target appearing on the PPI.

The functional operation of the CRP-55ADQ Indicator is described below:

A negative pulse taken from the Modulator triggers the square-wave multivibrator. The multivibrator furnishes: (a) negative

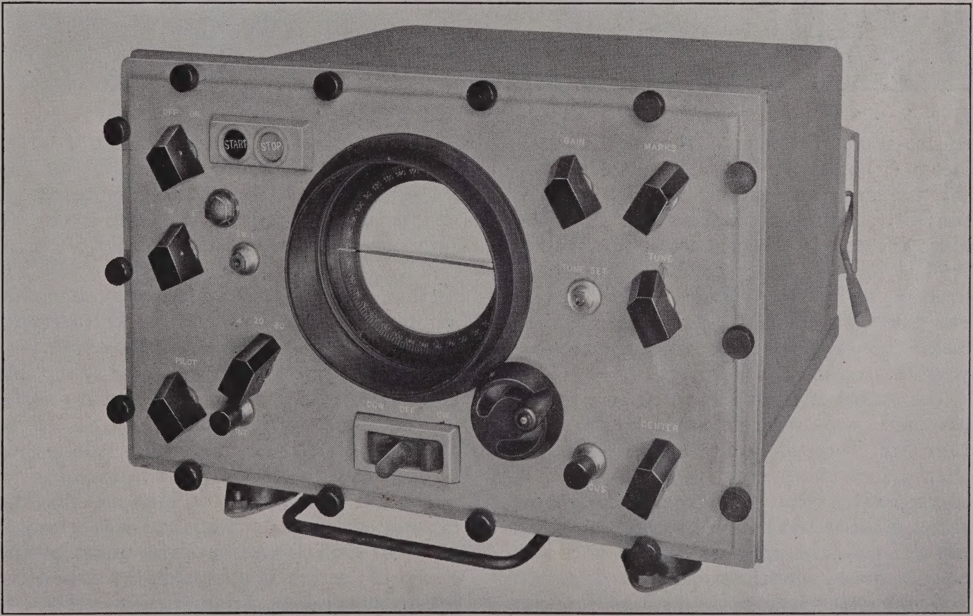


Fig. 82 — Plan Position Indicator Unit.

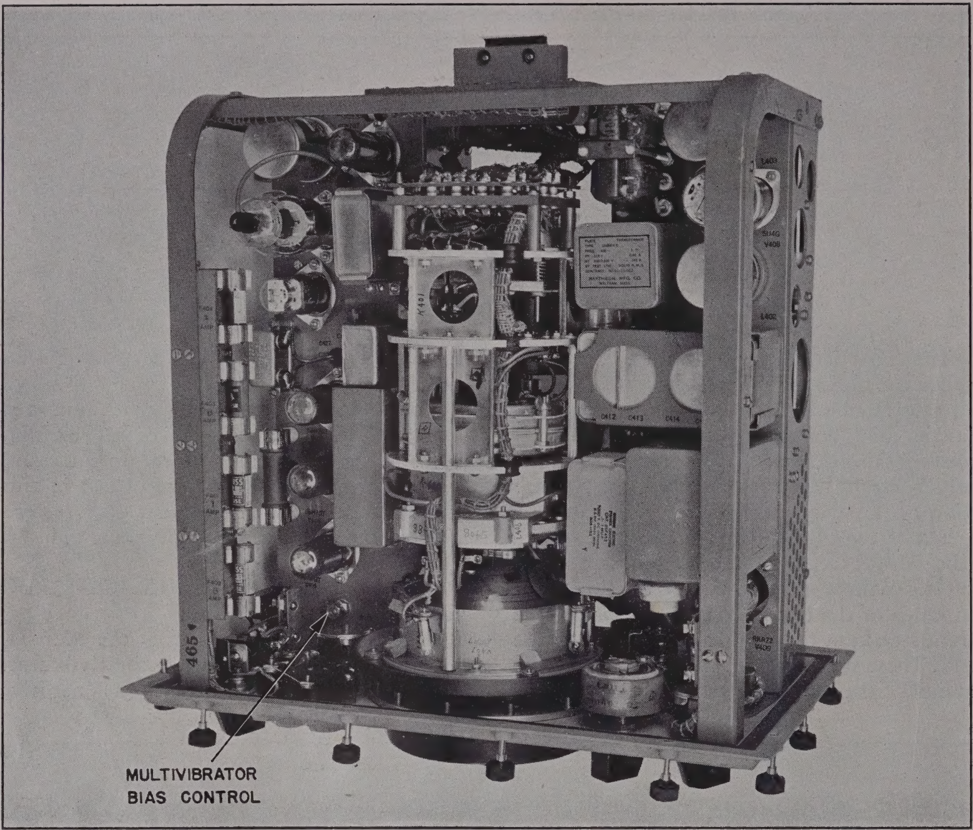


Fig. 83 — Plan Position Indicator: top view of chassis.

square waves for keying the marker oscillator; (b) negative square waves for keying the sweep generator; and (c) positive square waves for unblanking the PPI tube. Since these square waves are simultaneously applied to their respective circuits, synchronization of the first marker, the sweep start, and the PPI unblanking is accomplished. These three operations are also synchronized with the transmitted pulse.

The output of the marker oscillator appears as damped wave trains, recurring at the repetition rate. These are amplified, flattened, and shaped into sharp negative pulses (pips) in succeeding stages. These pips are applied through the MARKS Control to the cathode of the PPI tube and appear as well-defined dots equally spaced over the radial sweep.

As the sweep rotates, the markers trace concentric circles on the screen. These circles are spaced at intervals representing 1, 5, or 20 miles, depending upon the position of the RANGE Switch. The markers may be varied in intensity or removed from the screen by adjustment of the MARKS Control. (Fig. 7.)

Since the PPI tube employs magnetic deflection, the output of the sweep generator amplifier is a saw-tooth current. This current, when passed through the deflection coil, produces the desired linear sweep. The sweep coil is mounted in a rotatable yoke and is rotated in synchronism with the Antenna by means of a synchro system. Bearing information is thus transmitted from the Antenna to the PPI.

The PPI tube is normally biased so that the electron stream is cut off and the screen is blanked. During the outward travel of the sweep the screen is unblanked by a positive square wave; during the return travel of the sweep the screen remains blanked, thus pre-

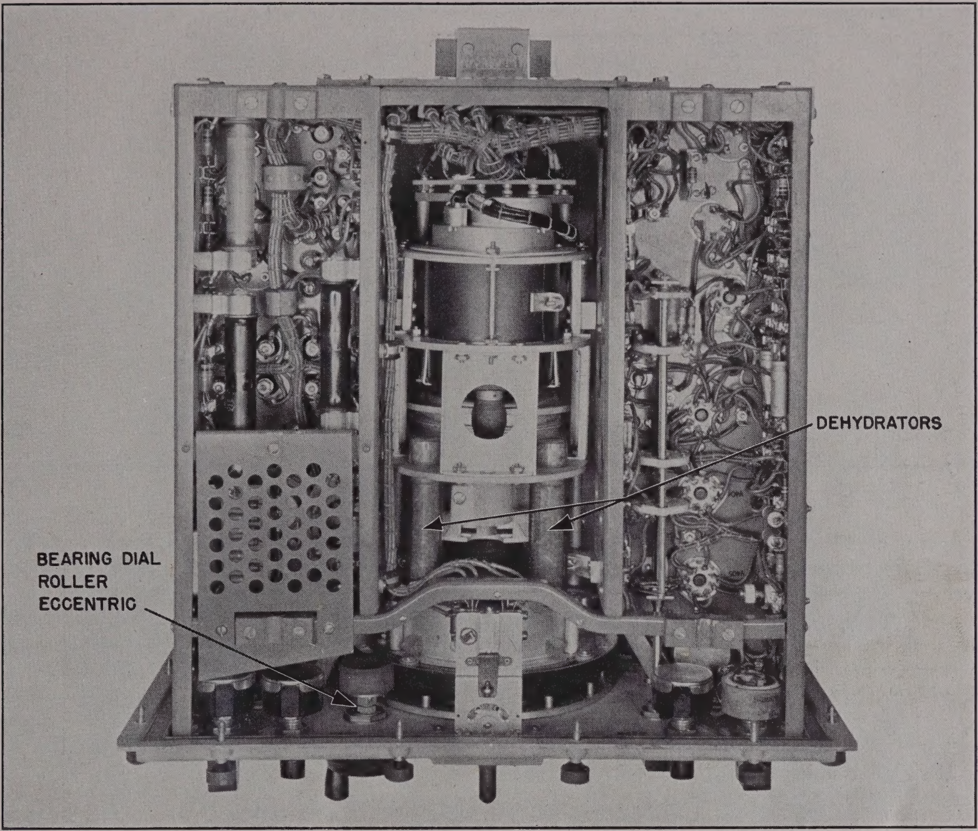


Fig. 84 — Plan Position Indicator: underside of chassis.

venting the appearance of undesirable return traces.

Signals in the form of video pulses are delivered from the Receiver to the video amplifier in the Indicator. The output of this amplifier is applied to the PPI tube, where it causes instantaneous intensification, thereby placing a spot on the screen. The distance of this spot from the screen center corresponds to the range of the target. Rotation of the sweep "smears" the target into a short arc, which is retraced at each revolution of the sweep. When the bearing vane is rotated until it bisects the target, bearings may be read from the bearing dial surrounding the PPI. Approximate range calculations may be made with the aid of the range markers on the screen. (See Fig. 8A.)

8.1 VIDEO AMPLIFIER

The video amplifier is a conventional two-stage resistance-coupled channel. A low-amplitude negative pulse from the Receiver is applied to the cathode of the first stage (V-406A), where it is amplified and then applied to the control grid of V-406B. The output of this stage is a positive pulse of sufficient amplitude to produce unblanking when applied to the #1 grid of the PPI tube. Series inductor L-407 in the amplifier output circuit improves the frequency response by counteracting stray output capacitances. A comparatively wide frequency

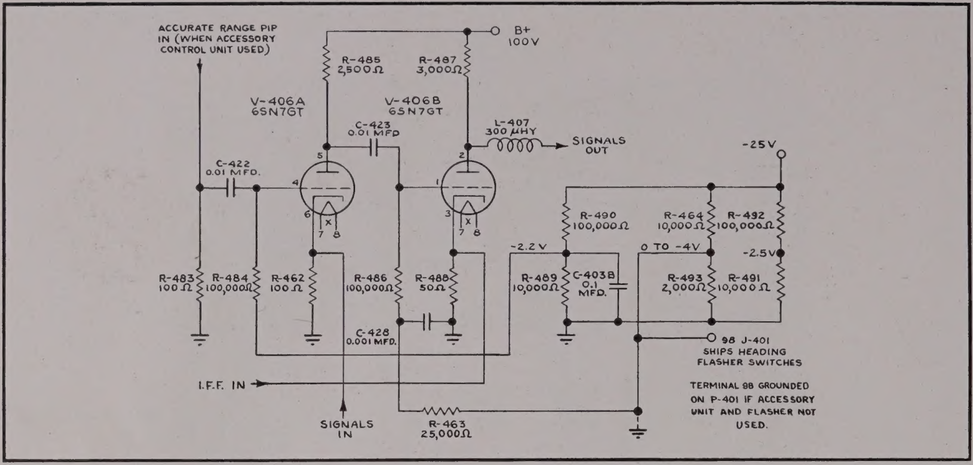

ACCURATE RANGE PIP IN (WHEN ACCESSORY CONTROL UNIT USED)
B+ 100V
R-485 2,500Ω
R-487 3,000Ω
V-406A 6SN7GT
V-406B 6SN7GT
C-423 0.01 MFD
L-407 300 µHY
SIGNALS OUT
-25V
C-422 0.01 MFD.
5
4
6
7 8
X
2
1
3
R-490 100,000Ω
R-464 10,000Ω
R-492 100,000Ω
-2.2 V
0 TO -4V
-2.5V
R-483 100Ω
R-484 100,000Ω
R-462 100Ω
R-486 100,000Ω
R-488 50Ω
R-489 10,000Ω
C-403B 0.1 MFD.
R-493 2,000Ω
R-491 10,000Ω
C-428 0.001 MFD.
98 J-401 SHIPS HEADING FLASHER SWITCHES
I.F.F. IN
TERMINAL 98 GROUNDED ON P-401 IF ACCESSORY UNIT AND FLASHER NOT USED.
SIGNALS IN
R-463 25,000Ω

Fig. 85 — Plan Position Indicator: video amplifier.

response band is provided to pass the high-frequency components of the pulse, thus preventing distortion of the waveform.

A second video input is provided at the grid of V-406A. This input takes positive signals; it may be used for the video input on systems having positive receiver output, or used as the input for positive "accurate range marks" when the Accessory Control Unit is installed.

IFF signals are applied to the cathode of the second amplifier stage (V-406B).

NOTE: When a true-bearing system is installed, a ship heading flasher circuit is provided to generate a negative pulse each time the Antenna sweeps past the ship's bow. This impulse is applied to the grid of V-406B and causes a bright line to appear on the PPI. Since the sweep is stabilized by the ship's compass, the line appears at the bearing corresponding to the ship's course. If a true-bearing system is not installed, the flasher circuit must be disabled by grounding terminal 98 on P-401 (see Fig. 93).

8.2 SQUARE-WAVE MULTIVIBRATOR

The square-wave multivibrator (V-401A and B) is the nerve center of the Indicator. It generates square waves of approximately 48, 244, and 976 microseconds duration for 4, 20, and 80 mile ranges respectively. In each case the start of the square wave is synchronized with the transmitted pulse. Each of these three pulse durations is slightly longer than the indicated values, thus permitting the sweep rate to be reduced by adjustment of the SW-L Control, and permitting targets to be viewed a short distance beyond the fifth marker.

The multivibrator operates as follows: Section A of V-401 operates with zero bias and normally conducts. Section B of the same tube is biased beyond the plate cutoff point. These triodes may be regarded as switches which alternately open and close. Normally section A is closed and section B is open, with the plate of section A near zero potential with respect to ground and with the plate potential of section B at about +300 volts. (See Fig. 86.)

Considering one cycle of operation, a negative trigger pulse from the Modulator is applied to the grid of section A (V-401), cutting off its plate current. The plate voltage of section A immediately jumps to near +300 volts, applying a positive voltage to the grid of section B and allowing plate current to flow in section B.

When current begins to flow in section B, its plate immediately drops to a potential nearly equal to its cathode voltage. Capacitor C-402 is thus left with a charge received when the plate of section B was at +300 volts. The capacitor now discharges exponentially through R-401 (4-mile range), producing a negative voltage drop which locks the multivibrator

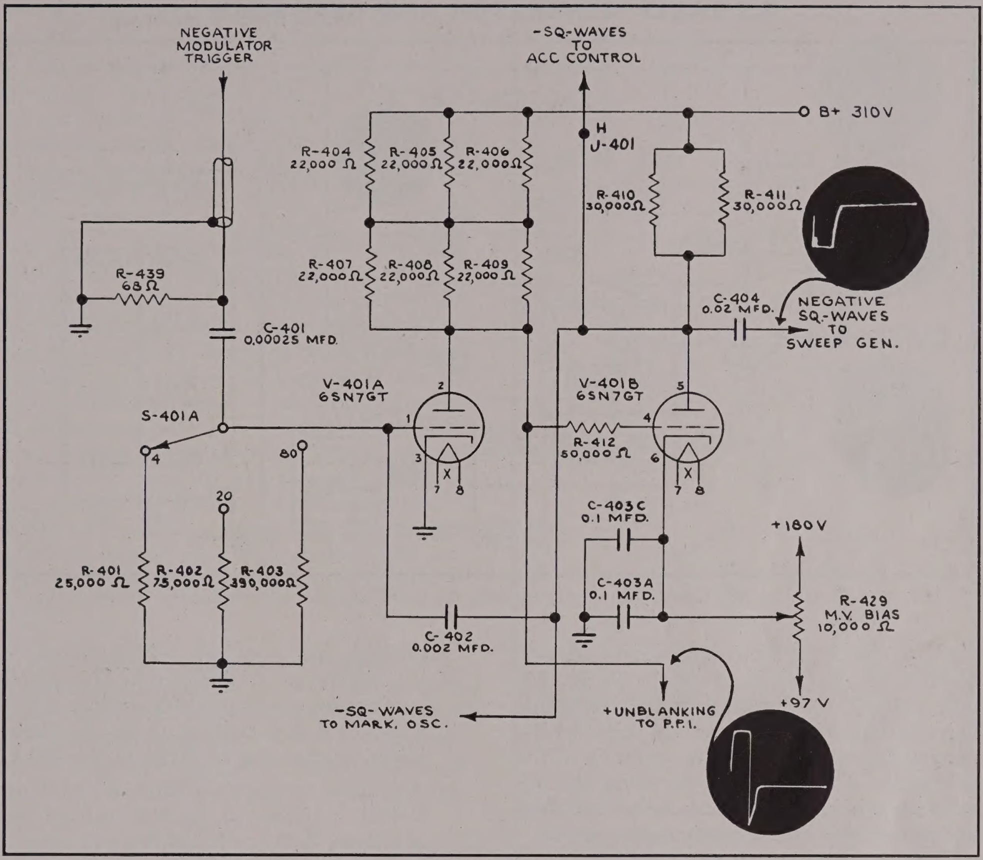

NEGATIVE MODULATOR TRIGGER
-SQ-WAVES TO ACC CONTROL
B+ 310V
H
J-401
R-404 22,000 Ω
R-405 22,000Ω
R-406 22,000Ω
R-410 30,000Ω
R-411 30,000Ω
R-407 22,000Ω
R-408 22,000Ω
R-409 22,000 Ω
R-439 68 Ω
C-401 0.00025 MFD.
C-404 0.02 MFD.
NEGATIVE SQ.-WAVES TO SWEEP GEN.
V-401A 6SN7GT
V-401B 6SN7GT
S-401A
4
80
20
2
1
3
7
8
5
4
6
X
R-412 50,000 Ω
C-403C 0.1 MFD.
C-403A 0.1 MFD.
+180V
R-429 M.V. BIAS 10,000 Ω
R-401 25,000 Ω
R-402 75,000Ω
R-403 390,000Ω
C-402 0.002 MFD.
+97 V
-SQ-WAVES TO MARK. OSC.
+UNBLANKING TO P.P.I.

Fig. 86 — Plan Position Indicator: square-wave multivibrator (synchroscope waveforms).

until the drop across R-401 becomes low enough to allow section A to draw plate current once more.

When this occurs, the plate potential of section A is suddenly lowered, reducing the positive grid voltage in section B and allowing its plate current to be cut off. The plate potential of section B then increases suddenly to +300 volts, recharging capacitor C-402. This action produces a positive drop across R-401, causing this resistor to draw slightly more current than normally. This, in turn, causes the plate potential of section A to go slightly nearer zero and to return to its normal quiescent value. The result is a low-amplitude negative "kick" at the end of the positive wave. No "kick" is present on the negative wave.

As previously explained, the plate potential of section A starts from near zero, suddenly increases to +300 volts, holds this potential for the duration of the square wave, then suddenly reduces to its starting potential. In section B, the plate potential starts from +300 volts, suddenly reduces to a lower value (the cathode voltage of section B), maintains this potential for the duration of the square wave, then suddenly increases to +300 volts.

Thus positive square waves are taken from the plate of section A and negative square waves are taken from the plate of section B.

The duration of the wave is determined by the time constant of the circuit composed of R-401 (R-402 or R-403) and C-402. A switch selects the resistor for the desired range.

The radial sweep of the PPI is magnetically operated by the plate current of sweep ampli-

8.3 SWEEP GENERATOR AND AMPLIFIER

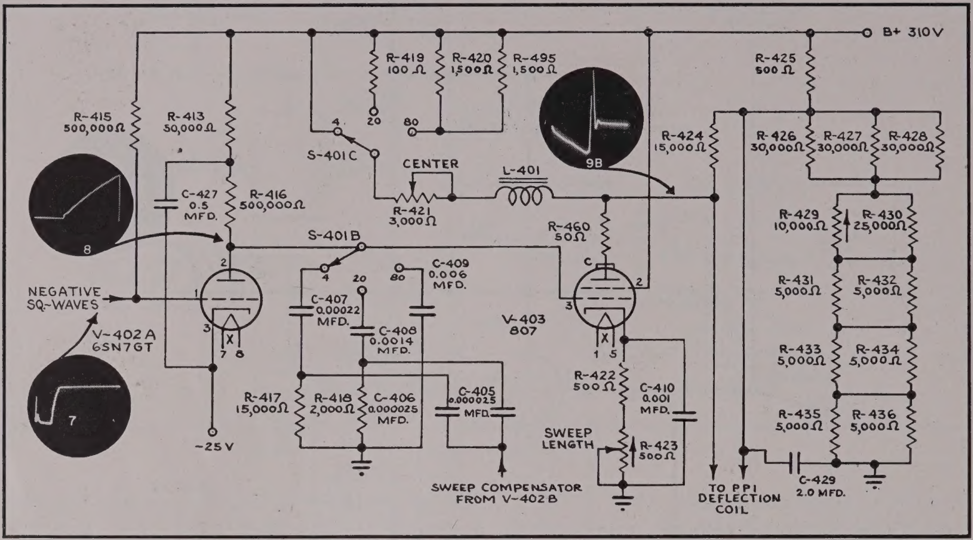

B+ 310V
R-419 100 Ω
R-420 1,500 Ω
R-495 1,500 Ω
R-425 500 Ω
R-415 500,000 Ω
R-413 50,000 Ω
4
20
80
S-401C
CENTER
L-401
9B
R-424 15,000 Ω
R-426 30,000 Ω
R-427 30,000 Ω
R-428 30,000 Ω
C-427 0.5 MFD.
R-416 500,000 Ω
R-421 3,000 Ω
R-460 50 Ω
R-429 10,000 Ω
R-430 25,000 Ω
8
S-401B
C-409 0.006 MFD.
C
2
NEGATIVE SQ-WAVES
1
C-407 0.00022 MFD.
R-431 5,000 Ω
R-432 5,000 Ω
V-402A 6SN7GT
3
C-408 0.0014 MFD.
V-403 807
7 8
1 5
R-433 5,000 Ω
R-434 5,000 Ω
R-422 500 Ω
C-410 0.001 MFD.
7
R-417 15,000 Ω
R-418 2,000 Ω
C-406 0.000025 MFD.
C-405 0.000025 MFD.
R-435 5,000 Ω
R-436 5,000 Ω
SWEEP LENGTH
R-423 500 Ω
-25 V
SWEEP COMPENSATOR FROM V-402B
TO PPI DEFLECTION COIL
C-429 2.0 MFD.

Fig. 87 — Plan Position Indicator: sweep generator and amplifier (synchroscope waveforms).

fier V-403, which is excited by sweep generator V-402A. On the two faster sweeps (4- and 20-mile ranges), the linearity of the saw-tooth wave is improved by an initial kick which partially compensates for the curvature of the saw-tooth. The saw-tooth wave on the 80-mile range is inherently more linear and does not require this initial compensating kick.

The saw-tooth sweep voltage is generated as follows: V-402A is normally biased to saturation, its cathode being biased to –25 volts and its grid being connected to +B through R-415. A negative square wave is applied to its grid, causing it to cut off. The voltage at the plate of V-402A, which was at approximately ground potential, then rises exponentially as capacitor C-407, C-408, or C-409 (depending on the range selected) charges through R-416. The value of each capacitor is such that the voltage at the plate of V-402A rises to about 110 volts before the square wave ends, at which time V-402A again conducts, dropping its plate potential to near zero.

Two methods are used on the two shorter ranges for improving the linearity of the voltage rise at the plate of V-402A:

(a) Resistor R-417 or R-418 is connected in series with capacitor C-407 or C-408. When V-402A cuts off, current starts flowing through the capacitor, which begins to increase its potential from zero. This initial current flow produces a voltage drop across R-417 or R-418, causing an instantaneous initial voltage rise at the plate of V-402A.

(b) A positive square wave from the plate of V-402B is applied to the high-voltage end of resistor R-417 or R-418 through capacitor C-406 or C-405. This produces a momentary flow of current through R-417 or R-418, thus causing an additional initial kick in the voltage at the plate of V-402A.

The grid of sweep amplifier V-403 is directly connected to the plate of V-402A. The plate current of V-403 will therefore increase as its grid voltage rises. This plate current flows through the deflection coil of the PPI tube.

Potentiometer R-423 (Sweep Length Control) adjusts the length of the sweep by controlling the bias of V-403, thereby varying the gain. Potentiometer R-421 (Center Control) adjusts the centering of the sweep start by controlling the steady current flowing through choke L-401 (the deflection coil) and through the voltage divider (resistors R-426 — R-436) to ground. Section C of S-401 (Range Switch) compensates for changes in centering when switching from one range to another.

8.4 MARKER OSCILLATOR

The marker oscillator is a shock-excited, tube-keyed L-C circuit. The oscillation frequency is practically independent of tube characteristics, being mainly determined by the value of inductance and capacitance in the circuit. (See Fig. 88.)

The keyer to tube V-402B normally operates with a moderate value of plate current flow. Energy is stored in the L-C circuit connected between cathode and ground of V-402B. When the negative pulse from the multivibrator is applied to the grid of the keyer tube, the resulting increased negative voltage causes the flow of plate current suddenly to stop. This allows the L-C circuit to oscillate at its natural period, and to generate the series of damped oscillations. Only the first four or five cycles of the wave train are used during each receiving period. Although damped, the amplitude of these is still great enough to be usable.

Three tuned circuits are provided, delivering damped wave trains of 2-, 10-, and 40-mile wavelengths for the generation respectively of 1-, 5-, or 20-mile markers. Switch S-401D automatically selects the proper tuned circuit as the range is changed.

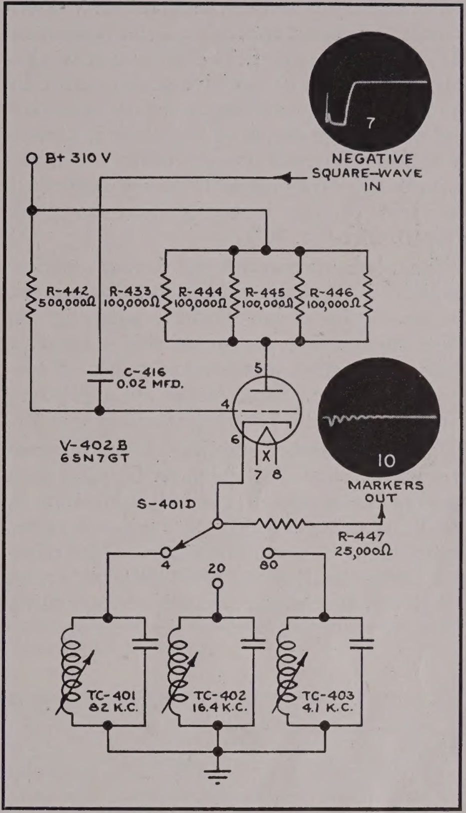

7
B+ 310 V
NEGATIVE SQUARE—WAVE IN
R-442 500,000Ω
R-433 100,000Ω
R-444 100,000Ω
R-445 100,000Ω
R-446 100,000Ω
C-416 0.02 MFD.
5
4
6
7 8
V-402 B 6SN7GT
10
MARKERS OUT
S-401D
R-447 25,000Ω
4
20
80
TC-401 82 K.C.
TC-402 16.4 K.C.
TC-403 4.1 K.C.

Fig. 88 — Plan Position Indicator: marker oscillator (synchroscope waveforms).

8.5 MARKER AMPLIFIERS AND SHARPENERS

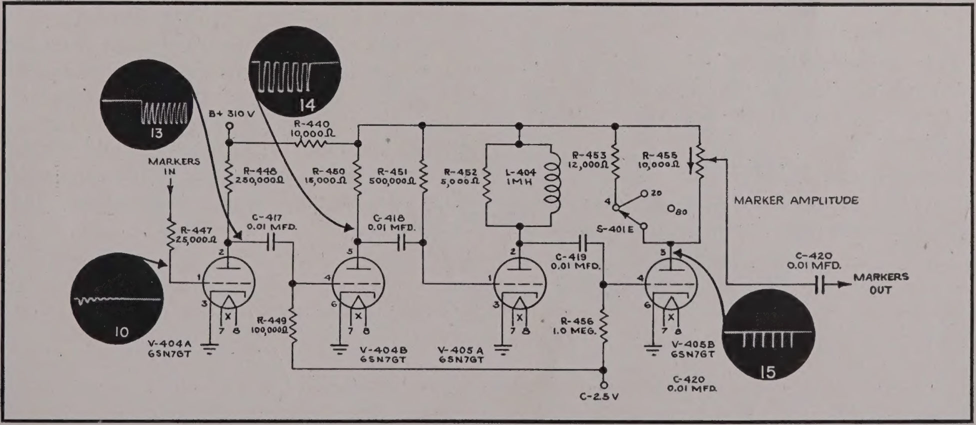

13
14
B+ 310 V
R-440 10,000Ω
MARKERS IN
R-448 250,000Ω
R-450 15,000Ω
R-451 500,000Ω
R-452 5,000Ω
L-404 1MH
R-453 12,000Ω
R-455 10,000Ω
4
20
80
MARKER AMPLITUDE
S-401E
C-417 0.01 MFD.
C-418 0.01 MFD.
R-447 25,000Ω
C-419 0.01 MFD.
C-420 0.01 MFD.
MARKERS OUT
10
R-449 100,000Ω
V-404A 6SN7GT
V-404B 6SN7GT
V-405A 6SN7GT
R-456 1.0 MEG.
V-405B 6SN7GT
15
C-420 0.01 MFD.
C-2.5V

Fig. 89 — Plan Position Indicator: marker amplifiers and sharpeners (synchroscope waveforms).

The grid of the first marker amplifier V-404A is directly coupled through a series resistor to the oscillating circuit. The excitation to this stage is flattened on positive peaks, owing to the flow of the grid current on the positive half-cycles. The output of this stage is a series of uniform flattened positive peaks and fairly uniform negative pulses. These are applied to the grid of the second marker amplifier V-404B. (See Fig. 89.)

The plate current of the second marker amplifier is normally cut off so as to prevent the generation of any positive pulses in the plate circuit. The output of this stage is a series of negative square-wave pulses of uniform amplitude. These pulses are applied to the grid of the third marker amplifier V-405A.

The third marker amplifier normally operates with a small positive bias. Its plate load consists essentially of a small inductance in parallel with a resistance. Only negative pulses are applied to the grid of this tube. This excitation causes small sharp peaks to occur across the plate inductance at intervals corresponding to the rise and fall of the square-wave excitation. These sharp positive and negative pulses are applied to the grid of the final marker amplifier V-405B.

The final marker amplifier is normally biased to cut off its plate current. Since its plate load is resistive, no positive peaks can appear at the output of this stage. The small, sharp, positive peaks of excitation generate high-amplitude sharp negative peaks at the output of V-405B. The plate load of this tube consists of potentiometer R-455, which is the MARKS Control, and any desired portion of these negative pulses can be applied through this control to the cathode of the PPI tube. These negative pulses reduce the positive bias on the PPI cathode, thereby instantaneously increasing the intensity of the trace. This momentary brightening effect causes small bright spots to appear along the sweep trace at intervals corresponding to calibrated distances. When the sweep is rotating, these spots appear as concentric circles, providing persistent range markers on the screen.

8.6 PPI TUBE

The PPI tube is a type 5FP7 5-in. cathode-ray tube having a long-persistence screen. It employs magnetic focusing and beam deflection.

The positive pulse output of the video amplifier is applied to grid #1. Negative marker pips are applied to the cathode and appear as equally spaced spots along the radial sweep on the screen (see Fig. 90).

The rotating sweep-coil yoke is driven from a synchro motor through a 10-to-1 reduction gear train. (The synchro system is explained on page 111.)

Potentiometer R-468 (Focus Control) varies the current through the focusing coil L-405, thus controlling the intensity of its coaxial magnetic field. Potentiometer R-459 (Intensity Control) adjusts the positive cathode bias, thus controlling the intensity of the trace. Normally the tube is biased beyond cutoff so as to blank the screen. During the time of the outward sweep only, positive square waves from the multivibrator are applied to grid #2 so as to unblank the screen momentarily.

The PPI tube with its sweep-coil rotating mechanism is mounted in a separate removable subassembly known as the PPI assembly. Since this subassembly must be removed in replacing the tubes, replacement should not be attempted before reading the instructions outlined on page 60 under Maintenance and Service.

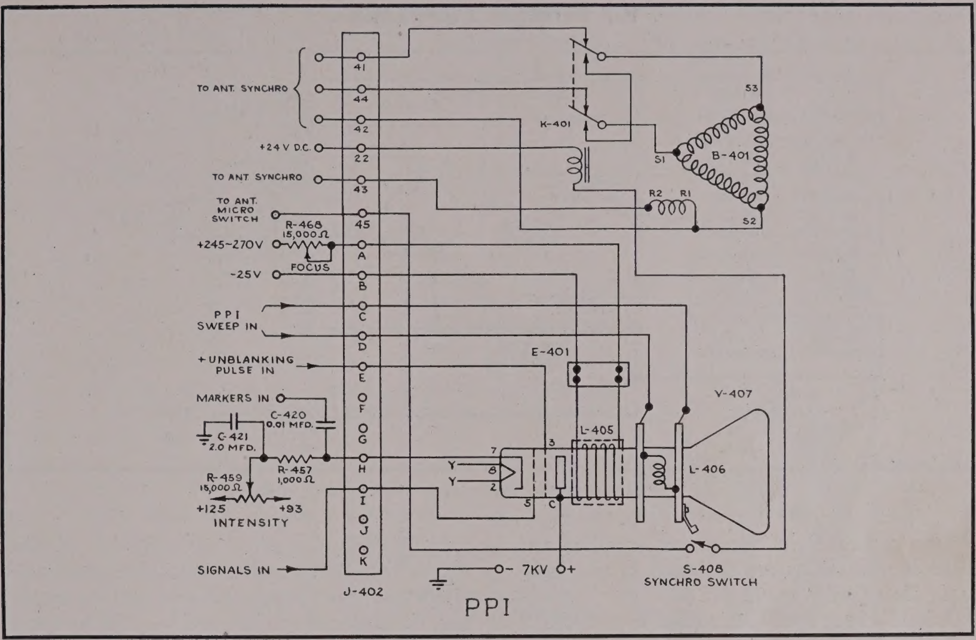

TO ANT. SYNCHRO
41
44
42
+24 V D.C.
22
TO ANT. SYNCHRO
43
TO ANT. MICRO SWITCH
45
R-468
15,000Ω
+245-270V
A
FOCUS
-25V
B
PPI SWEEP IN
C
D
+UNBLANKING PULSE IN
E
MARKERS IN
F
C-420
0.01 MFD.
G
C-421
2.0 MFD.
R-457
1,000Ω
H
R-459
15,000Ω
+125
+93
INTENSITY
I
J
K
SIGNALS IN
J-402
K-401
S3
S1
B-401
R2
R1
S2
E-401
V-407
L-405
L-406
7
8
2
5
3
C
Y
Y
7KV
S-408
SYNCHRO SWITCH
PPI

Fig. 90 — Plan Position Indicator: PPI assembly.

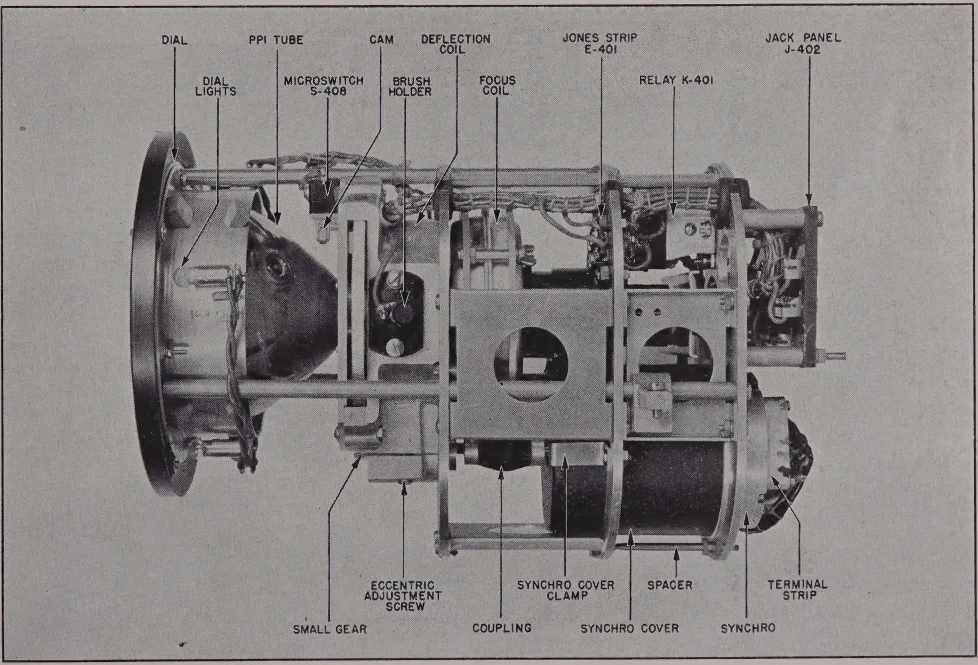

DIAL
PPI TUBE
CAM
DEFLECTION COIL
JONES STRIP E-401
JACK PANEL J-402
DIAL LIGHTS
MICROSWITCH S-408
BRUSH HOLDER
FOCUS COIL
RELAY K-401
ECCENTRIC ADJUSTMENT SCREW
SYNCHRO COVER CLAMP
SPACER
TERMINAL STRIP
SMALL GEAR
COUPLING
SYNCHRO COVER
SYNCHRO

Fig. 91 — Plan Position Indicator: PPI assembly.

8.7 POWER SUPPLIES

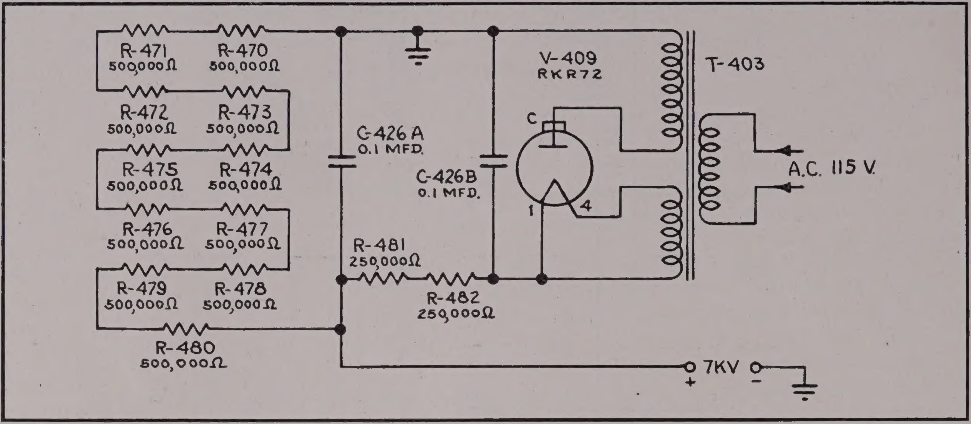

R-471
500,000Ω
R-470
500,000Ω
R-472
500,000Ω
R-473
500,000Ω
R-475
500,000Ω
R-474
500,000Ω
R-476
500,000Ω
R-477
500,000Ω
R-479
500,000Ω
R-478
500,000Ω
R-480
500,000Ω
C-426 A
0.1 MFD.
C-426B
0.1 MFD.
R-481
250,000Ω
R-482
250,000Ω
V-409
RKR72
C
1
4
T-403
A.C. 115 V.
7KV
+
-

Fig. 92 — Plan Position Indicator: 7-kv. power supply.

Two separate rectifier power supplies and filter combinations are included in the Indicator Unit (see Figs. 92 and 94).

A half-wave supply, using one type RKR-72 tube (V-409), furnishes 7 kv. d.c. for the accelerating anode of the PPI tube.

A full-wave supply, using one type 5U4-G tube (V-408), furnishes 300 volts d.c. for the marker oscillator and its amplifiers, the multivibrator, the sweep generator and its amplifier, the video amplifier, and the PPI focusing coil. To provide bias voltages, the bleeder on this supply is grounded at a point 300 ohms from the negative end.

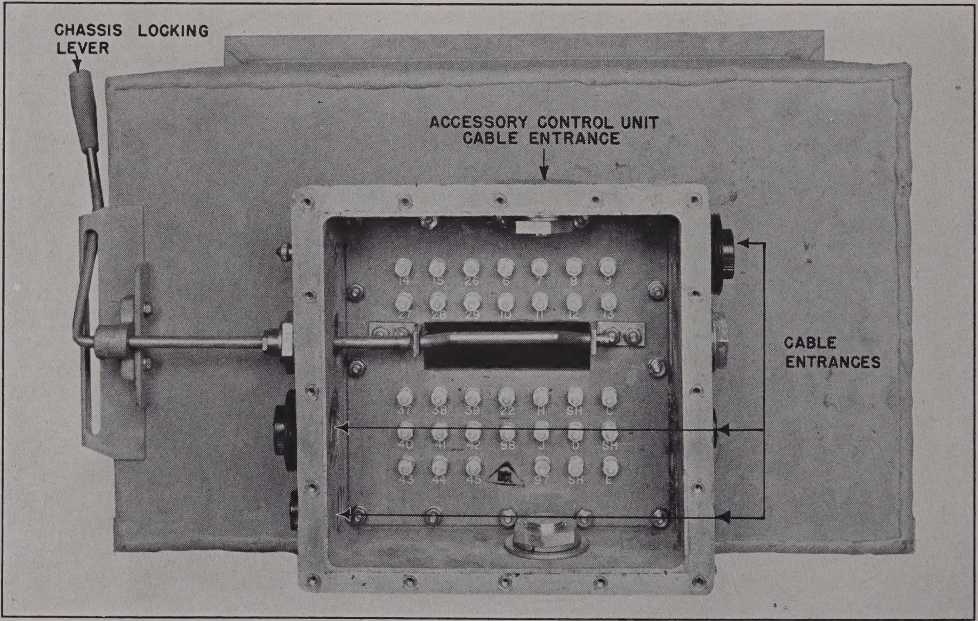

CHASSIS LOCKING LEVER
ACCESSORY CONTROL UNIT CABLE ENTRANCE
CABLE ENTRANCES

Fig. 93 — Plan Position Indicator: terminals at rear of case.

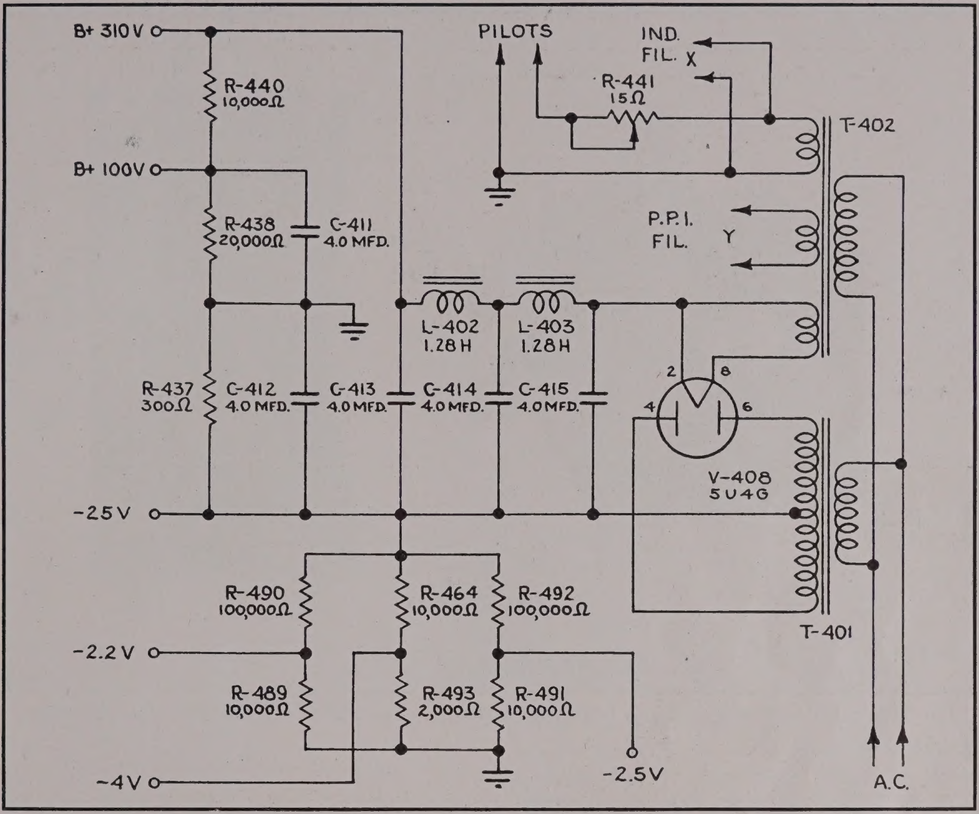

B+ 310V
R-440
10,000Ω
B+ 100V
R-438
20,000Ω
C-411
4.0 MFD.
R-437
300Ω
C-412
4.0 MFD.
C-413
4.0 MFD.
C-414
4.0 MFD.
C-415
4.0 MFD.
L-402
1.28 H
L-403
1.28 H
PILOTS
IND.
FIL.
X
R-441
15Ω
T-402
P.P.I.
FIL.
Y
2
8
4
6
V-408
5U4G
T-401
-25V
R-490
100,000Ω
R-464
10,000Ω
R-492
100,000Ω
-2.2V
R-489
10,000Ω
R-493
2,000Ω
R-491
10,000Ω
-2.5V
-4V
A.C.

Fig. 94 — Plan Position Indicator: 300-volt power supply.

8.8 IFF CONTROL UNIT AND LINE VOLTMETER

This optional unit comprises a key-type switch and a 400-cycle line voltmeter housed in a small metal case (see Fig. 95). The unit mounts near the Indicator.

The switch is used to connect the IFF equipment to the Indicator. It has both locking and non-locking positions. A gain control is also employed, but is not supplied by the manufacturer.

The line voltmeter, which is independent of the IFF equipment, is used to indicate the output voltage of the 400-cycle Alternator. The meter scale has a red line at the 115-volt position to serve as a guide for proper voltage adjustment.

The Accessory Control Unit contains a switch and gain control for controlling the external IFF equipment. The A.C.U. also contains a 400-cycle voltmeter wired to the 400-cycle line. Inasmuch as the A.C.U. duplicates the function of the IFF Control Unit, the two units are never used simultaneously. Whenever the A.C.U. is added to equipment, the IFF Control Unit must be removed.

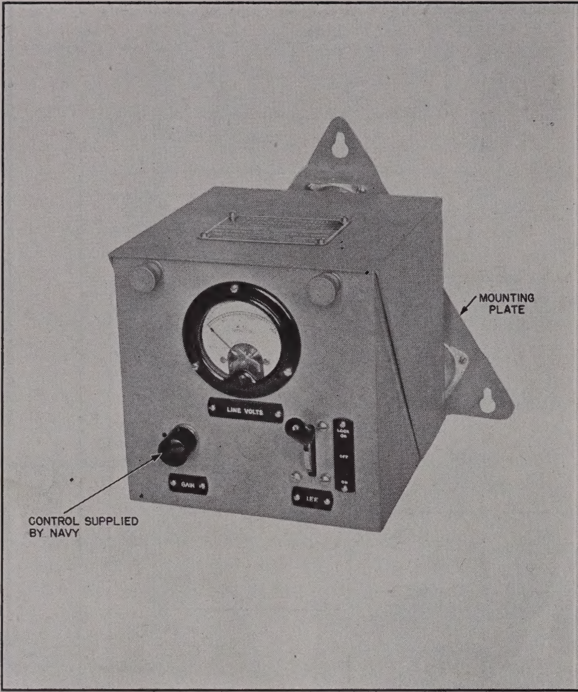

MOUNTING PLATE
LINE VOLTS
GAIN
IFF
LOCK ON
OFF
ON
CONTROL SUPPLIED BY NAVY

Fig. 95A — IFF Control Unit and Line Voltmeter.

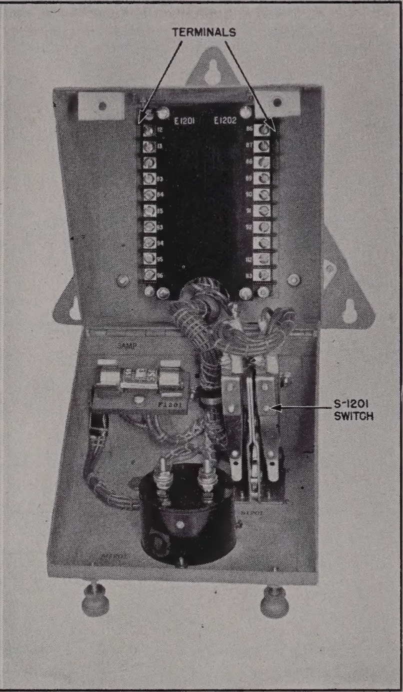

TERMINALS
E1201
E1202
F1201
S-1201 SWITCH

Fig. 95B — IFF Control Unit: interior.

Section 9 — Antenna

9.0 GENERAL

The Antenna Assembly comprises the following (see Figs. 96–99):

(a) A drive mechanism including a drive motor and gear train;

(b) A synchro system including a synchro generator and gear train;

(c) A rotating radiating system including a nozzle radiator, a reflector in the form of a paraboloidal section, and r.f. fittings for coupling the rotating reflector to the stationary wave-guide;

(d) A locked gear differential for later conversion of the system to a true-bearing system;

(e) A supporting pedestal and base plate.

NOTE: Two types of Antennas are currently in use: type CRP-66AFL and type CRP-66AGE. Although the two types are more or less equivalent, they differ widely in mechanical details.

9.1 DRIVE MECHANISM

The radiating system is rotated by a reversible d.c. motor (see Fig. 41). Mechanical coupling to the Antenna is accomplished by a simple speed-reduction worm gear train. On the low-speed end of the worm train, a spur gear drives a larger spur gear attached to the rotating assembly. The latter is virtually locked in position by the gear train when the drive motor is off, preventing drifting of the Antenna in high winds.

9.2 SYNCHRO SYSTEM

Coupled to the rotating assembly through the locked gear differential is a 5SF synchro generator. Each revolution of this assembly produces ten revolutions of the synchro. The stator windings of the synchro are connected to the stator windings of another 5SF synchro B-401 operating as a motor in the Indicator. Rotation of the antenna synchro causes corresponding rotation of the indicator synchro. The latter synchro drives the radial sweep coil of the PPI tube through a 10-to-1 speed reduction train, thus causing the PPI sweep to follow the rotation of the Antenna.

The synchro system in its basic form is designed to indicate relative bearings only, and must be aligned after installation so that the PPI sweep points to zero when the Antenna points to the bow of the ship. The synchro system may be converted to indicate either true or relative bearings by the addition of the true-bearing accessory unit (Bearing Control Unit), as described in Sec. 9.3.

Since the torque of a synchro motor driven by a synchro generator falls to a low value when the alignment error between the two synchros approaches zero, an error of several degrees would result if the synchro motor in the Indicator were made to drive any considerable mechanical load. The loading effect of the rotating deflection coil is therefore minimized by driving the coil through a 10-to-1 gear reduction train.

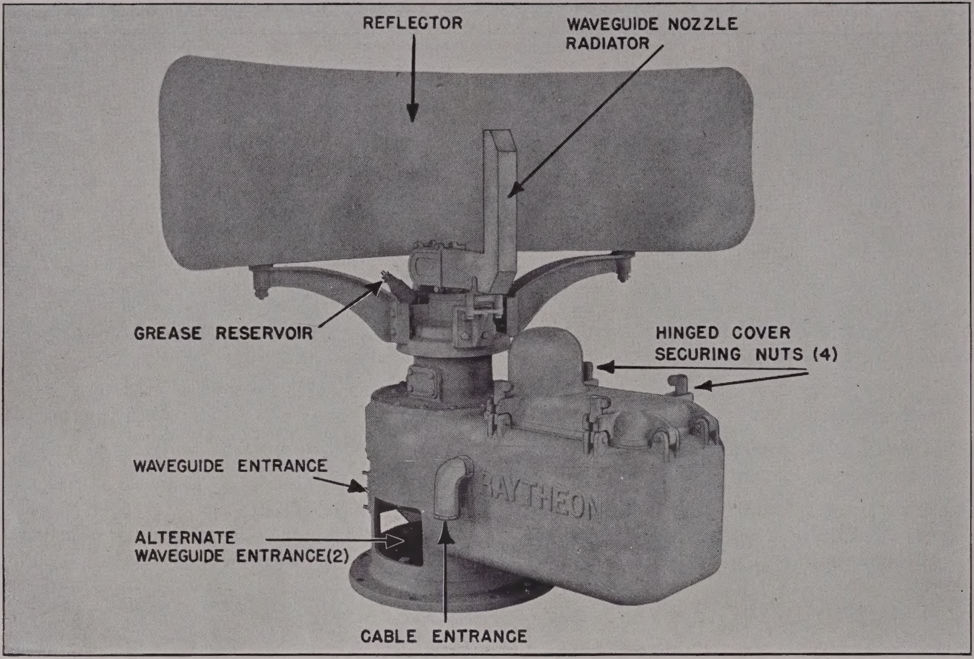

REFLECTOR
WAVEGUIDE NOZZLE RADIATOR
GREASE RESERVOIR
HINGED COVER SECURING NUTS (4)
WAVEGUIDE ENTRANCE
ALTERNATE WAVEGUIDE ENTRANCE(2)
RAYTHEON
CABLE ENTRANCE

Fig. 96 — Antenna CRP-66AFL.

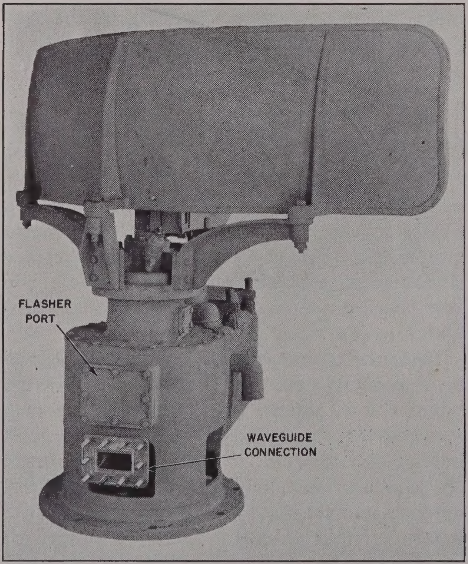

FLASHER PORT
WAVEGUIDE CONNECTION

Fig. 97 — Antenna CRP-66AFL.

Owing to the use of this 10-to-1 speed ratio, it is possible for the synchro system to get out of step in multiples of complete revolutions, thereby introducing an error of 36° or of multiples of 36°. To correct such errors a synchro-phasing system is included which automatically checks the PPI sweep and re-synchronizes it with the Antenna once every revolution (see Fig. 42).

Synchro phasing is accomplished as follows: The rotating sweep coil assembly in the Indicator includes a cam having a width of about 12°. This cam closes micro-switch S-408 once every revolution as the sweep passes the 0° position. The rotating assembly of the Antenna includes another cam having a width of about 18°, which opens antenna micro-switch S-501 once every revolution as the Antenna sweeps past the bow. The micro-switches are connected in series with the coil of alignment relay K-401 in the Indicator. When this relay closes, the stator leads S-1 and S-3 of synchro motor B-401 are disconnected from the synchro generator and short-circuited, stopping the sweep at 0°.

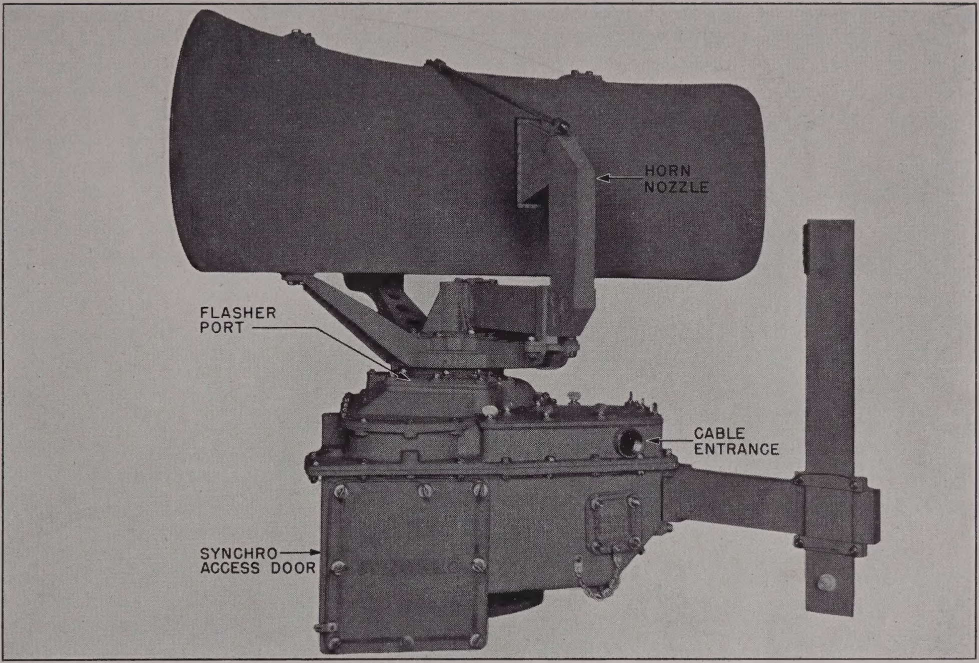


Fig. 98 — Antenna CRP-66AGE.

If the antenna and the PPI sweep are exactly synchronized, relay K-401 remains open. This is because the antenna micro-switch opens just before the indicator micro-switch closes, and (owing to the greater width of its cam) remains open a short time after the PPI switch opens. Should the two switches get out of synchronism, the PPI sweep will stop when it reaches 0° because both micro-switches are closed, thus causing the relay to close and stop the motor. In this event, the Antenna continues to rotate, and as it nears the bow of the ship, the antenna cam opens the associated micro-switch, opening the relay. This action closes the circuit connecting the two synchros and starts them rotating once more in exact synchronism.

9.3 TRUE-BEARING SYSTEMS

The Radar may be converted at a later date so that the PPI Bearing Dial will indicate targets in true bearings. This is done by coupling the ship's heading bearing and antenna bearing into a mechanical differential.

The projected true-bearing system for SO-1 Equipment is intended for ships having a d.c. (step-by-step) gyro compass. Bearing information from the ship's gyro is converted to a.c. information (Autosyn system) by a step-by-step to Autosyn converter built into the Bearing Control Unit. This a.c. bearing information is used to operate the true-bearing system.

The differential has two mechanical inputs and one mechanical output. The Antenna is mechanically coupled through gearing to one differential input. The second differential input is geared to a torque unit and connects the ship's compass to the system. The output of the differential is geared to the antenna synchro generator, which in turn causes rotation of the PPI deflection coil in the Indicator.

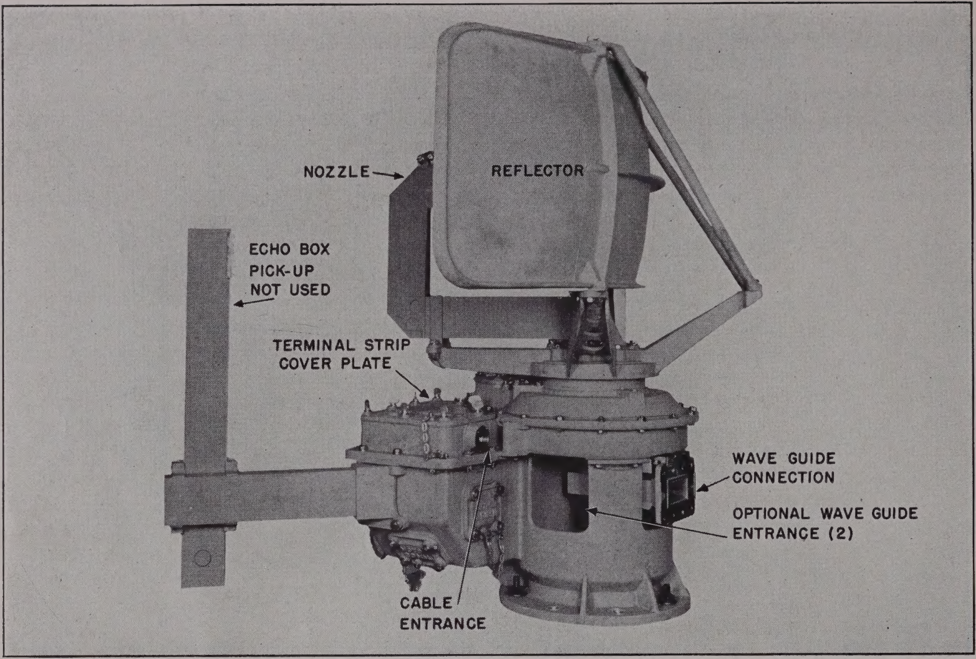

NOZZLE
REFLECTOR
ECHO BOX PICK-UP NOT USED
TERMINAL STRIP COVER PLATE
WAVE GUIDE CONNECTION
OPTIONAL WAVE GUIDE ENTRANCE (2)
CABLE ENTRANCE

Fig. 99 — Antenna CRP-66AGE.

NOTE: The mechanical differential is already installed on all SO-1 Antennas. The mechanical input which will be connected to the ship's compass system is supplied locked, making the system a relative-bearing one until converted.

The torque unit consists of two parts in a single case: a two-phase induction motor and an Autosyn (synchro generator). The direction and amount of rotation of the two-phase motor is controlled by the ship's compass through the Autosyn, which has its rotor coupled to the motor mechanically and (through the servo amplifier) electrically.

In operation the torque unit is locked in position by the ship's compass, through the servo system, thus locking one input of the differential while the ship is on a steady course. This causes the Antenna to turn the synchro generator at ten times the antenna rate; and since the synchro motor in the Indicator follows in exact synchronism, it also rotates at ten times the antenna speed. The indicator synchro motor is coupled to the PPI deflection coil assembly through a 10-to-1 reduction gear train, causing the PPI to rotate in exact synchronism with the Antenna.

To understand the operation of the torque unit it is best to follow its action with the Antenna stopped while the ship's course is changing. Assume that the ship is on a 0° course with the Antenna stopped pointing dead ahead. Should the ship change to a 90° course, the Antenna will also point in the same direction; however, the PPI trace will move from 0° to 90° on the Bearing Dial. This is because the ship's compass repeats the course change to the differential through the servo system via the torque unit, causing the differential to turn. As the antenna input to the differential is locked, the torque unit causes the antenna synchro generator to rotate sufficiently and in the proper direction to result in a 90° clockwise rotation of the PPI. As the Antenna was previously pointing north but changed to east as the ship maneuvered, the PPI indicates true bearing. With the Antenna rotating and the ship turning, the differential combines the instantaneous antenna bearing and the ship's bearing, causing the synchro generator to repeat the true antenna bearing to the PPI.

The system may be operated as a relative-bearing indicator by turning the switch on the Bearing Control Unit to "Relative." This sends a true-north electrical signal from a transformer to the servo system. Since the electrical information is always that of true north regardless of the ship's course, all bearings indicated are relative to the ship's bow.

Ship Heading Flasher Operation

During conversion to true bearing, two micro-switches are added in the Antenna and are so connected to the video amplifier in the Indicator as to cause a flash on the PPI as the antenna beam passes the ship's bow. Since indicated bearings are true, the flash appears on the PPI at a bearing corresponding to the ship's heading.

One of the micro-switches is a single-pole double-throw switch with both outside contacts tied together. The two switch leads are connected to the grid return of the second video amplifier in the Indicator through terminals 98 on SH (ground) on P-401. Since the switch is normally closed, an additional bias circuit on the second video amplifier is short-circuited. As the Antenna rotates, the cam on the Antenna strikes the micro-switch causing the switch arm to move to the other contact, again short-circuiting the additional bias. During the interval when the switch was operating, the circuit opened for a short period (as the switch arm moved from one contact to the other) injecting a negative pulse into the video amplifier. This pulse appears on the PPI as a brilliant flash. As the switches are initially adjusted so that the flash appears as the Antenna sweeps across the bow, the flash appears on the screen at the bearing corresponding to the ship's course. The second micro-switch is added as a "keying" switch, preventing two flashes per operation and causing the flash to appear at the correct ship's course bearing, regardless of whether the Antenna is rotating clockwise or counterclockwise. (See Fig. 40.)

9.4 THEORY OF ANTENNA RADIATION

The SO-1 antenna employs a reflector taking the form of a paraboloidal section, which concentrates and re-radiates the energy in a narrow beam.

R.F. energy is sprayed onto this reflector from a nozzle which, in turn, is excited from a rotatable section of stub-supported coaxial cable. The input end of the coaxial line is coupled to the waveguide transmission line and to the Transmitter.

In actual operation, r.f. energy from the Transmitter travels up the waveguide and excites a quarter-wavelength inner conductor projecting into the waveguide. This inner conductor rotates with the antenna nozzle and reflector. The waveguide is closed a short distance beyond the coupling point. This distance is critical and is permanently fixed. Energy flowing up the coaxial system is re-radiated into the upper waveguide section which terminates in the antenna nozzle.

The inner coaxial conductor is supported by a locked slug near the bottom and by a quarter-wave stub at the top. The rotating waveguide section terminates in the fixed iris and coaxial radiator. The nozzle literally sprays r.f. energy

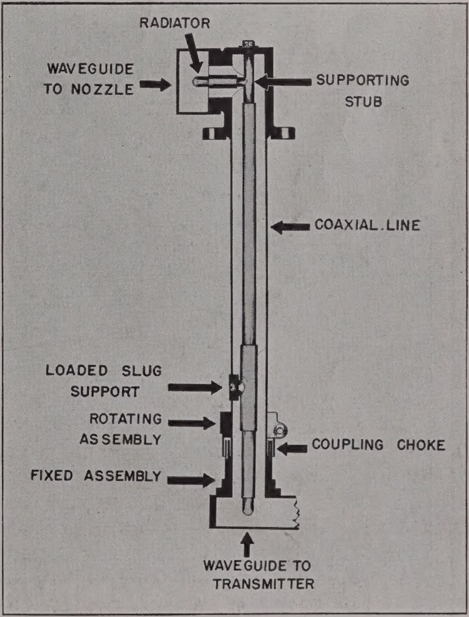


FIG. 100 — ANTENNA CRP-66AFL: CROSS SECTION OF R.F. SHAFT.

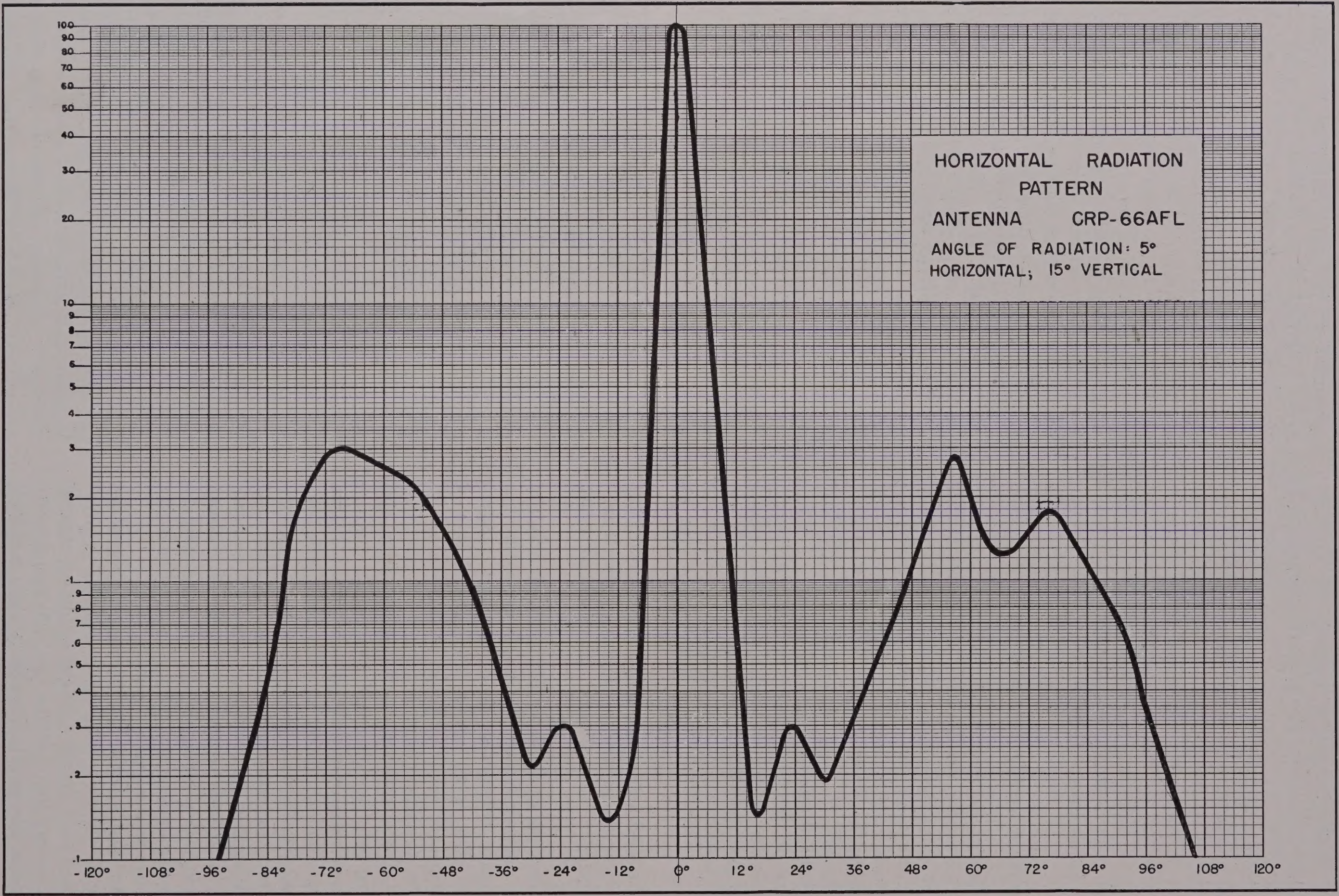

HORIZONTAL RADIATION PATTERN
ANTENNA CRP-66AFL
ANGLE OF RADIATION: 5° HORIZONTAL; 15° VERTICAL
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
-120°
-108°
-96°
-84°
-72°
-60°
-48°
-36°
-24°
-12°
0°
12°
24°
36°
48°
60°
72°
84°
96°
108°
120°

Fig. 101.

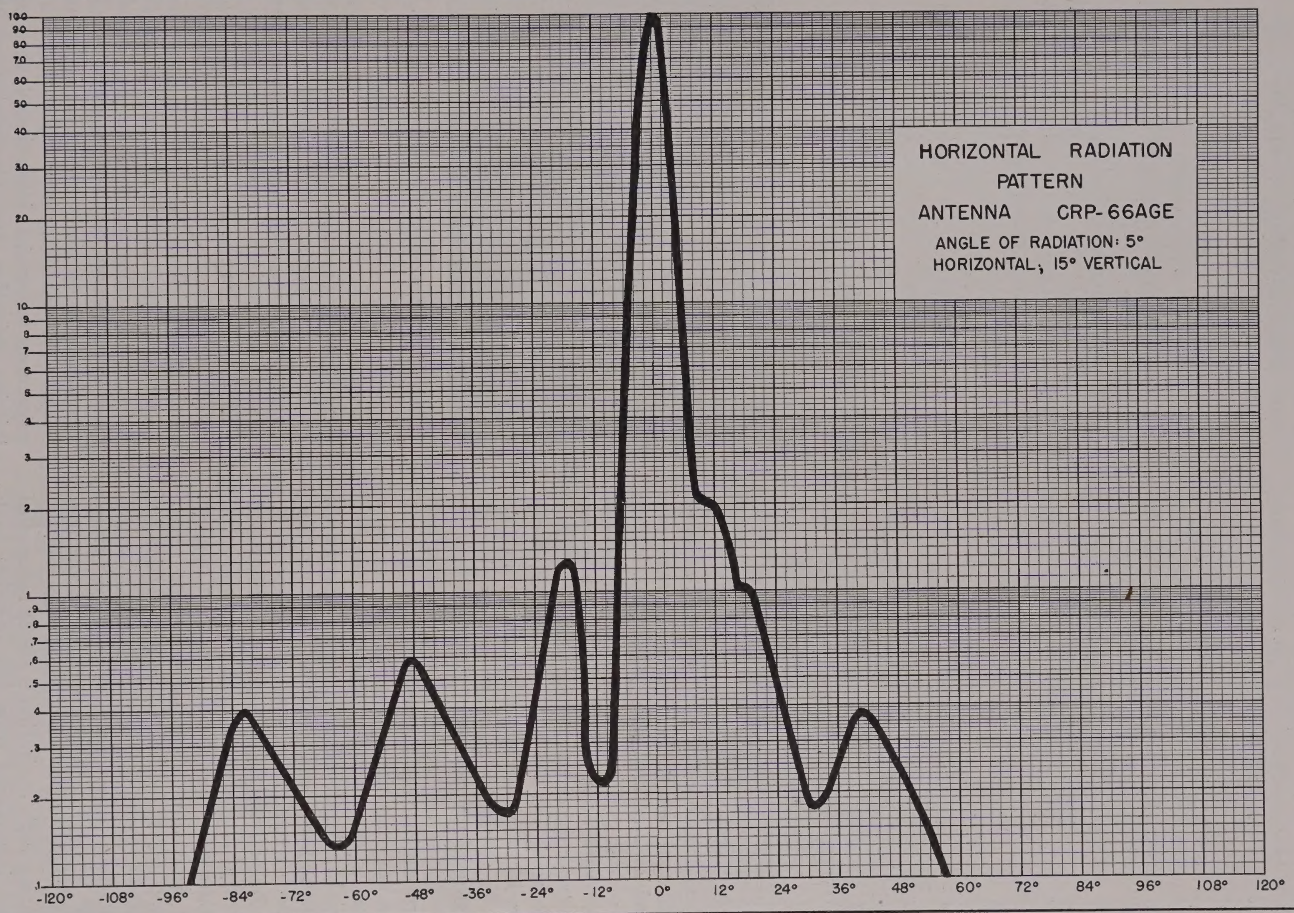

HORIZONTAL RADIATION PATTERN
ANTENNA CRP-66AGE
ANGLE OF RADIATION: 5° HORIZONTAL, 15° VERTICAL
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
-120°
-108°
-96°
-84°
-72°
-60°
-48°
-36°
-24°
-12°
0°
12°
24°
36°
48°
60°
72°
84°
96°
108°
120°

Fig. 102.

onto the surface of the reflector. This reflector confines and concentrates the energy into a narrow beam confined to 5° in the horizontal and 15° in the vertical plane.

Coupling between the rotating coaxial line and the upper waveguide section (nozzle) is accomplished by means of quarter-wave radiators. This radiator is an extension of the coaxial line into the waveguide. The upper waveguide section is plugged at one end and terminates in an iris and special nozzle at the other end. The position of the radiator and iris, the design of the nozzle, and the placement of the reflector are all very critical. These are correctly adjusted at the factory for proper terminating characteristics and should never require adjustment in the field.

The coaxial line, with the exception of half the coupling choke, rotates with the Antenna. The lower outer section of fixed coaxial line, which is made a part of the waveguide, connects to the upper rotating section through a coupling choke.

The whole transmission line is matched in both directions; that is, all terminating impedances are matched both during transmission of outgoing energy and during reception of echo signals.

9.5 RESONANCE CHAMBER

To permit tuning of the Receiver in the absence of actual targets, a Resonance Chamber (Echo Box) is provided (see Fig. 103).

The Resonance Chamber is actually a high-Q resonant circuit. In physical appearance it resembles a covered half-gallon pail. At the top of the pail is an adjustable disk plunger which varies the volume of the chamber and thus tunes the circuit. The plunger is adjusted by rotating a nut on a threaded shank. A cam lever is provided for quickly detuning the chamber when not in use so as to prevent the masking of actual echoes.

Energy is taken from the waveguide near the transmitter end by means of a small probe extending into the waveguide, and is transmitted to the Echo Box through a length of coaxial cable. Coupling between the coax and the Echo Box is effected by inductive coupling through a small loop in the Echo Box.

If the Resonance Chamber is properly tuned, the energy picked up from the waveguide causes oscillation within the Resonance Chamber. This excitation occurs for only one microsecond out of each 2500 microseconds; but owing to the high Q of the chamber, damped oscillations persist after the excitation stops. After 10 or 15 microseconds of exponential decay, these oscillations virtually die out.

During each excitation a small amount of energy is returned from the chamber back through the coaxial line to the waveguide. Here the energy is delivered via the r.f. system to the Receiver like a signal from an actual target. Assuming that this re-radiated energy affects the Receiver for ten microseconds, it will show up on the PPI tube as a solid line extending from the start of the sweep to about the 1-mile position.

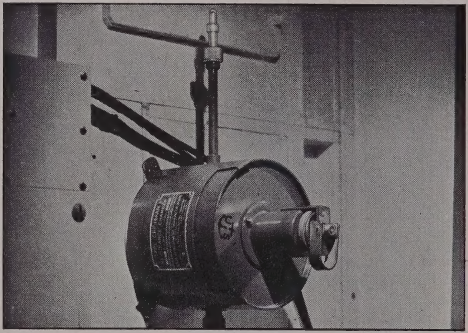


Fig. 103 — Resonance Chamber Installed.

In tuning the Receiver with the aid of the Resonance Chamber, optimum tuning is indicated by maximum length of the artificial echo signal as seen on the screen. This is because the receiver sensitivity increases as the tuning adjustment approaches its optimum, thus permitting reception and observation of the damped waves for a longer period.

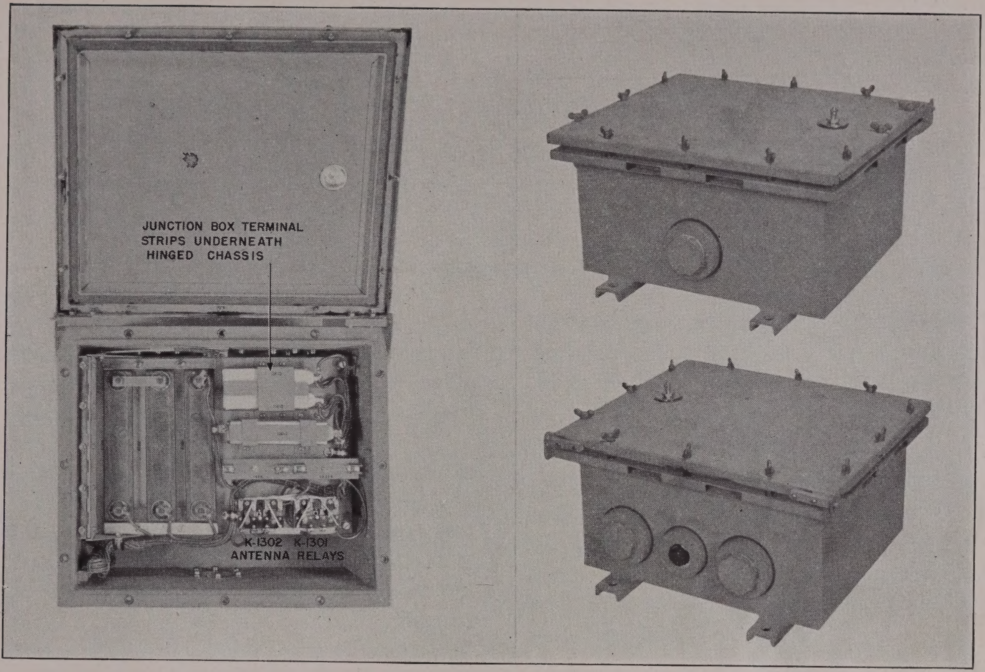


Fig. 104 — Junction Box.

9.6 JUNCTION BOX

General

The Junction Box contains relays, capacitors and resistors for the control of antenna rotation. It also contains terminal strips for connections between the Antenna, Indicator, and Motor-Alternator-Modulator.

The unit is watertight and may be mounted outside if desired. All cable entrances must be made through watertight terminal tubes. Two silica-gel dehydrators are provided for the absorption of moisture.

Antenna Control

Since the antenna drive motor draws a relatively large current, it cannot be directly controlled by the small Antenna Switch on the Indicator. Instead, the indicator switch is used to control the two relays in the Junction Box, which in turn control antenna rotation. When the indicator switch is set to "Off," the relays open and short-circuit the armature of the antenna drive motor through a 5-ohm resistor. This results in a rapid deceleration of the motor, thus preventing coasting of the antenna reflector after the Antenna Switch is opened. Capacitors are connected across the relay contacts to prevent pitting of the contacts and to reduce noise.

The extra terminal strip E-110 provides connections for a PPI Repeater. As no repeater is used on SO-1 Equipment, this terminal strip need not be cabled.

Routine maintenance instructions for the Junction Box are given on page 66.

NOTE: On very early equipments, a much larger Junction Box was used. The extra space was originally intended for a remote-tuned echo box which was not supplied. Since the Junction Box was designed for this purpose, it was stamped with component numbers of the 600 series. Therefore, when ordering replacement parts for early units, the component numbers should be changed to the 1300 series. For example C-603 should be ordered as C-1303.

Section 10 — Accessory Control Unit

GENERAL

The Accessory Control Unit (A.C.U.) is intended for optional use with SO-Series Radar Equipment. Its main purpose is to enable ranges to be determined with greater accuracy than the usual range markers permit.

Means are provided for superimposing a movable "accurate range mark" on the PPI tube. Rotation of a hand-crank moves this mark along the sweep on the PPI screen until it coincides with the signal to be ranged. The range is then read directly from an illuminated dial mechanically coupled to the hand-crank.

The Accessory Control Unit is also used: (a) to indicate the output voltage of the 400-cycle Alternator; (b) to control external IFF equipment when used; (c) to control the ship heading flash circuit which is provided for observing relative bearing when a true-bearing system is installed; (d) to house special controls for X-band operation (not used on SO-1 Equipments).

Instructions for operating the A.C.U. will be found in full in Sec. 3 of this book; these instructions, together with material on installation, maintenance, and circuit analysis, are included in the instruction book which accompanies the unit.

When the A.C.U. is installed, the IFF Control Unit and Line Voltmeter is not required, since the A.C.U. performs the functions of the other unit.

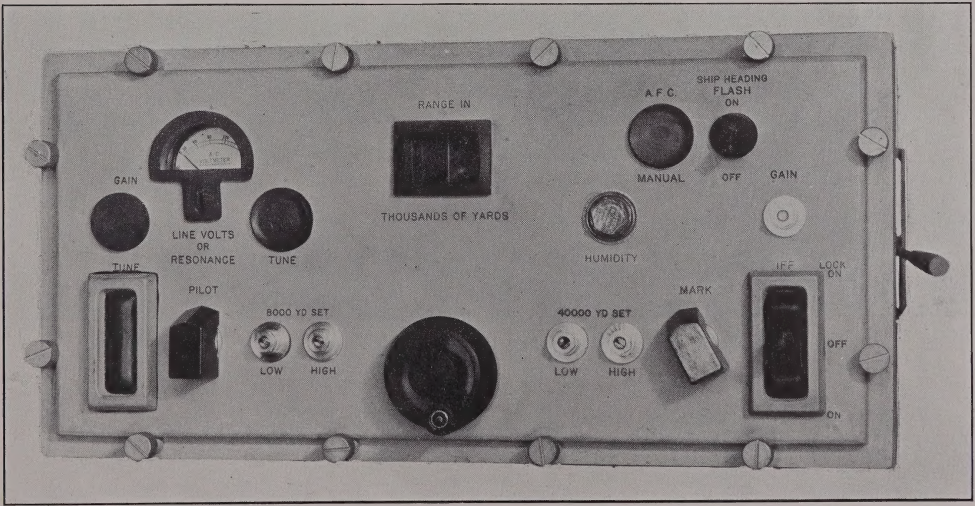

RANGE IN
THOUSANDS OF YARDS
A.F.C.
SHIP HEADING FLASH
ON
MANUAL
OFF
GAIN
GAIN
LINE VOLTS OR RESONANCE
TUNE
TUNE
HUMIDITY
PILOT
8000 YD SET
LOW
HIGH
40000 YD SET
LOW
HIGH
MARK
IFF
LOCK ON
OFF
ON

Fig. 105 — Accessory Control Unit: front panel.

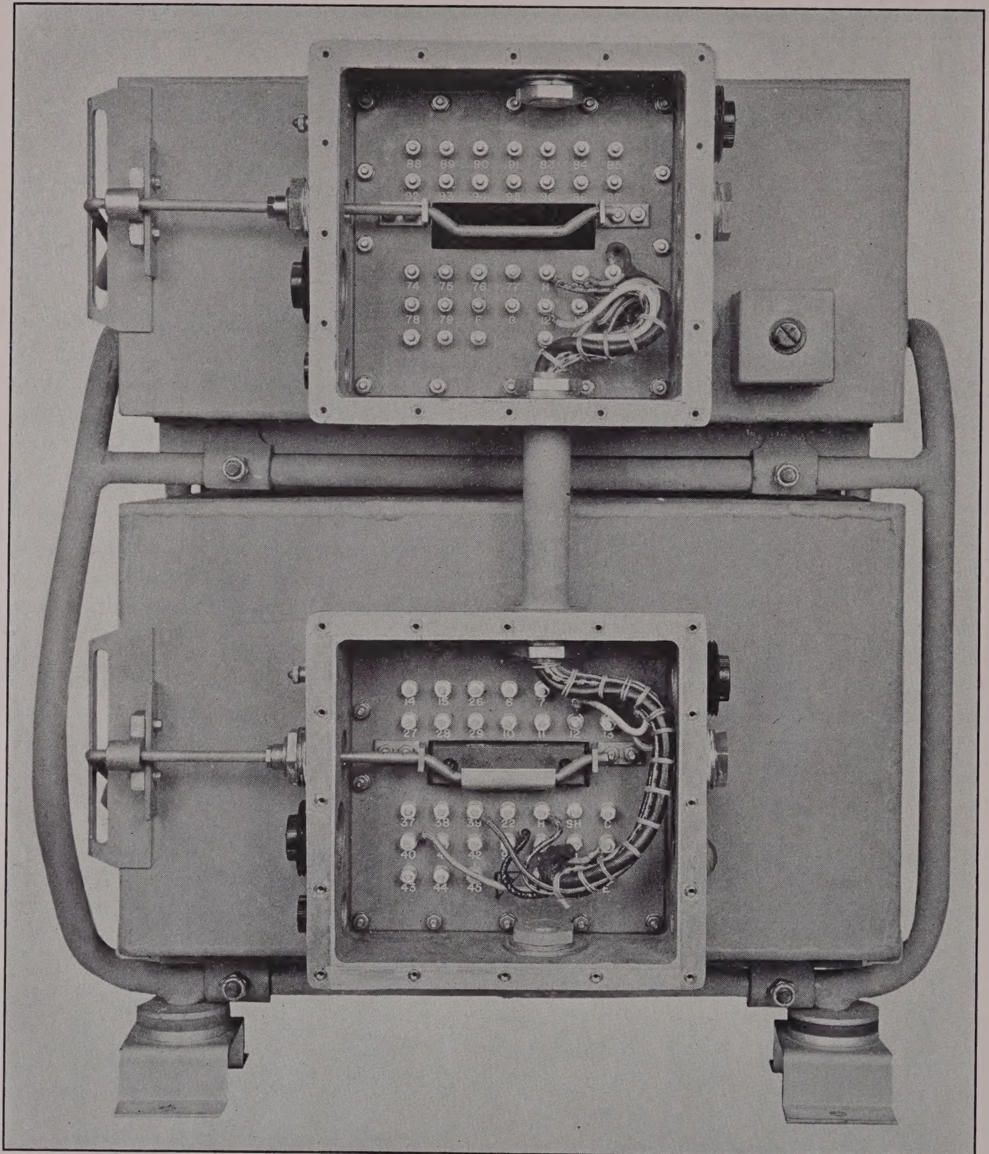
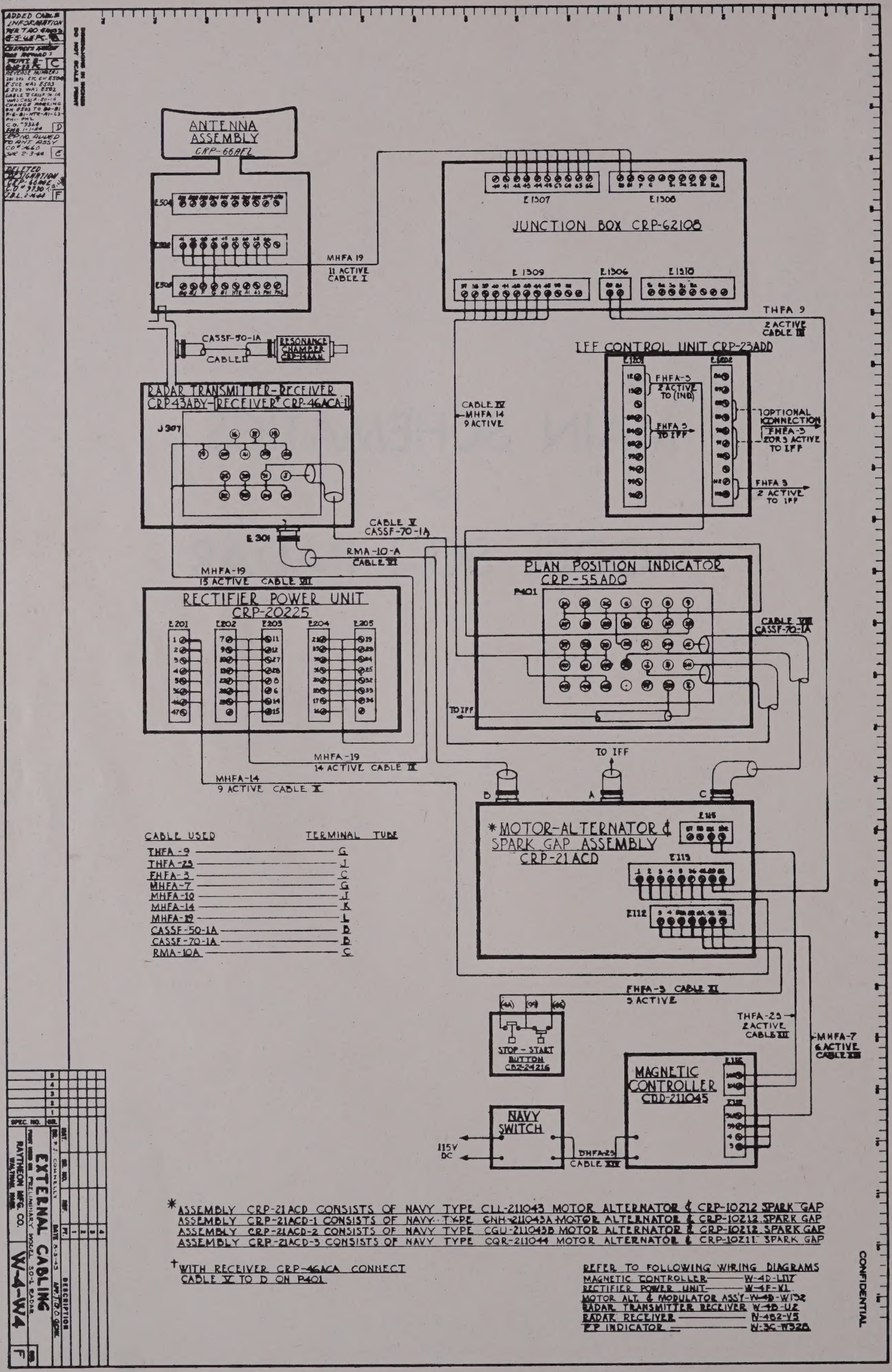

74
75
76
77
78
79
14
15
26
6
7
27
28
29
10
11
12
13
37
38
39
22
H
SH
C
40
42
43
44
45

Fig. 106 — Accessory Control and Indicator Units: rear view.

MAIN SCHEMATICS

FOR

MODEL SO-1 RADAR


ANTENNA ASSEMBLY CRP-66AFL
E504
E502
E503
MHFA 19
11 ACTIVE CABLE I
JUNCTION BOX CRP-62108
E1307
E1308
E1309
E1306
E1310
THFA 9
2 ACTIVE CABLE III
CASSF-50-1A
CABLE II
RESONANCE CHAMBER CRP-14AAN
RADAR TRANSMITTER-RECEIVER CRP43ABY-RECEIVER† CRP-46ACA-1
J307
IFF CONTROL UNIT CRP-23ADD
E1201
E1202
FHFA-3 2 ACTIVE TO (IND)
FHFA 3 TO IFF
OPTIONAL CONNECTION FHFA-3 2 OR 3 ACTIVE TO IFF
FHFA 3 2 ACTIVE TO IFF
CABLE IV MHFA 14 9 ACTIVE
E301
CABLE V CASSF-70-1A
RMA-10-A CABLE VI
MHFA-19 15 ACTIVE CABLE VII
PLAN POSITION INDICATOR CRP-55ADQ
P401
CABLE VIII CASSF-70-1A
RECTIFIER POWER UNIT CRP-20225
E201
E202
E203
E204
E205
TO IFF
MHFA-19 14 ACTIVE CABLE IX
MHFA-14 9 ACTIVE CABLE X
TO IFF
B
A
C
*MOTOR-ALTERNATOR & SPARK GAP ASSEMBLY CRP-21ACD
E115
E113
E112
FHFA-3 CABLE XI 3 ACTIVE
THFA-23 2 ACTIVE CABLE XII
MHFA-7 6 ACTIVE CABLE XIII
STOP-START BUTTON CBZ-24216
MAGNETIC CONTROLLER CDD-211045
NAVY SWITCH
115V DC
DHFA-23 CABLE XIV
EXTERNAL CABLING
W-4-W4
F
RAYTHEON MFG. CO. WALTHAM, MASS.
CONFIDENTIAL

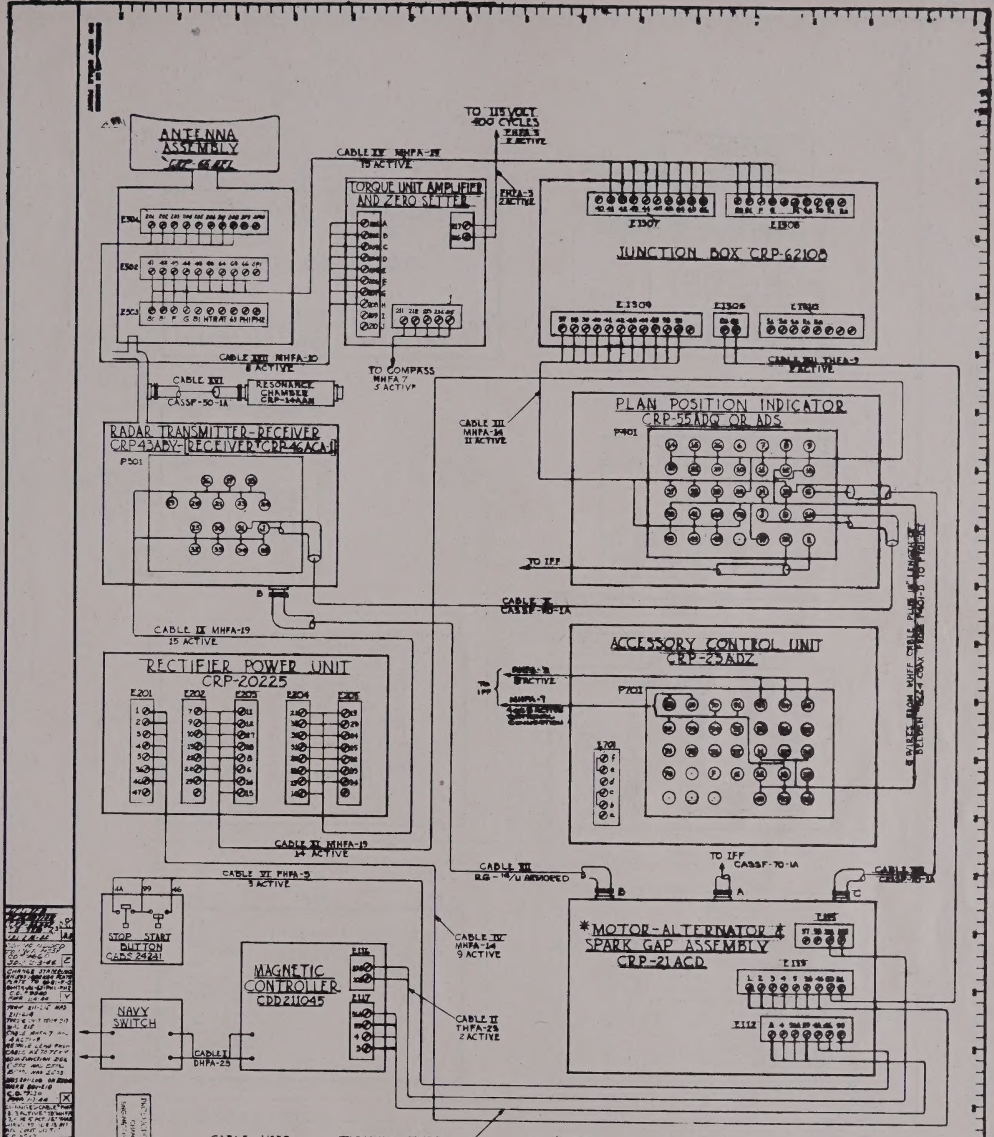
CABLE USED	TERMINAL TUBE
THFA -9	G
THFA -23	J
FHFA - 3	C
MHFA-7	G
MHFA-10	J
MHFA-14	K
MHFA-19	L
CASSF-50-1A	B
CASSF-70-1A	B
RMA-10A	C

*ASSEMBLY CRP-21ACD CONSISTS OF NAVY TYPE CLL-211043 MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-1 CONSISTS OF NAVY TYPE CNH-211043A MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-2 CONSISTS OF NAVY TYPE CGU-211043B MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-3 CONSISTS OF NAVY TYPE CQR-211044 MOTOR ALTERNATOR & CRP-10211 SPARK GAP

†WITH RECEIVER CRP-46ACA CONNECT CABLE V TO D ON P401

REFER TO FOLLOWING WIRING DIAGRAMS
MAGNETIC CONTROLLER — W-4D-L117
RECTIFIER POWER UNIT — W-4F-K1
MOTOR ALT. & MODULATOR ASS'Y — W-4D-W152
RADAR TRANSMITTER RECEIVER — W-4D-U2
RADAR RECEIVER — W-4B2-V5
PP INDICATOR — W-3C-W328

Model SO-1 — W-4-W4 sub F External Cabling (CRP-66AFL Antenna Only)


ANTENNA ASSEMBLY CRP-66AFL
E504
E502
E503
TO 115 VOLT 400 CYCLES PHASE 3 ACTIVE
CABLE XV MHFA-19 15 ACTIVE
TORQUE UNIT AMPLIFIER AND ZERO SETTER
FHFA-3 2 ACTIVE
JUNCTION BOX CRP-62108
E1307
E1308
E1309
E1306
E1310
CABLE XVIII MHFA-10 8 ACTIVE
TO COMPASS MHFA 7 5 ACTIVE
CABLE XVI CASSF-50-1A
RESONANCE CHAMBER CRP-14AAN
CABLE XII MHFA-14 11 ACTIVE
CABLE THFA-9 2 ACTIVE
PLAN POSITION INDICATOR CRP-55ADQ OR ADS
P401
RADAR TRANSMITTER-RECEIVER CRP43ADY-[RECEIVER†CRP-46ACA-1]
P501
TO IFF
CABLE X CASSF-50-1A
CABLE IX MHFA-19 15 ACTIVE
RECTIFIER POWER UNIT CRP-20225
E201
E202
E203
E204
E205
ACCESSORY CONTROL UNIT CRP-23ADZ
TO IFF
MHFA-10 8 ACTIVE
MHFA-7
P701
E701
8 WIRES FROM MHFF CABLE PLUS 10' LENGTH OF BELDEN 8224 COAX FROM P401-D TO P701-DJ
CABLE XI MHFA-19 14 ACTIVE
CABLE VI FHFA-3 3 ACTIVE
CABLE XIII RG-14/U ARMORED
TO IFF CASSF-70-1A
CABLE XIV CASSF-70-1A
STOP START BUTTON CABS 24241
CABLE IV MHFA-14 9 ACTIVE
*MOTOR-ALTERNATOR & SPARK GAP ASSEMBLY CRP-21ACD
E115
E113
E112
MAGNETIC CONTROLLER CDD211045
E116
E117
CABLE II THFA-23 2 ACTIVE
NAVY SWITCH
CABLE I DHFA-23
EXTERNAL CABLING SO-1
RAYTHEON MFG. CO.
W-4-W2

CABLE USED	TERMINAL TUBE
THFA-9	G
DHFA-23	J
FHFA-3	C
MHFA-7	G
MHFA-10	J
MHFA-14	K
MHFA-19	L
CASSF-50-1A	B or C
CASSF-70-1A	B or C
RG-14/U ARMORED	C

CABLE III MHFA-7
6 ACTIVE

† NOTE

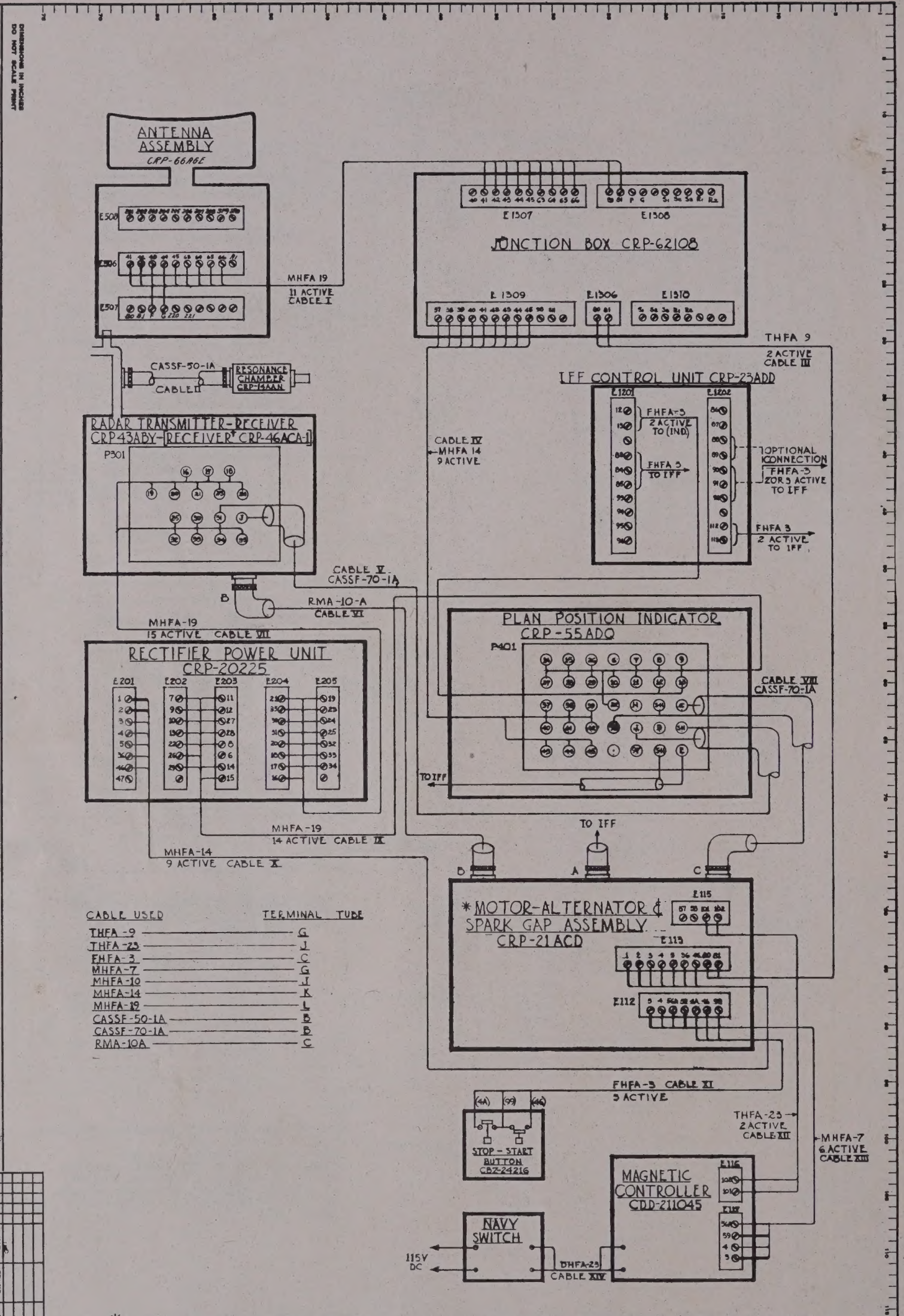
WITH RECEIVER CRP-46ACA CONNECT AS FOLLOWS:
J303 TO TERMINAL J ON P501
TERMINAL J TO TERMINAL D ON P401
TERMINAL DJ ON P701 TO TERMINAL J ON P401
JUMPER DJ ON P701 TO TERMINAL J ON P701
USE EXTERNAL CABLING DIAGRAM W-4-W4 WHEN TRUE BEARING AND ACCESSORY CONTROL UNITS ARE NOT USED.

* ASSEMBLY CRP-21ACD CONSISTS OF NAVY TYPE CLL-211043 MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-1 CONSISTS OF NAVY TYPE CLL-211043A MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-2 CONSISTS OF NAVY TYPE CLL-211043B MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-3 CONSISTS OF NAVY TYPE CLL-211044 MOTOR ALTERNATOR & CRP-10211 SPARK GAP

REFER TO FOLLOWING WIRING DIAGRAMS
MAGNETIC CONTROLLER — W-4D-L117
RECTIFIER POWER UNIT — W-4F-V1
MOTOR ALT. & MODULATOR ASS'Y — W-4D-W136
RADAR TRANSMITTER-RECEIVER — W-4B-U2
RADAR RECEIVER — W-4B2-V5
P.P. INDICATOR — W-5C-[illegible]
ACCESSORY CONTROL UNIT — [illegible]
TORQUE UNIT AMP. & ZERO SETTER —

CONFIDENTIAL

Model SO-1 — W-4-W2 sub A External Cabling Including True Bearing and A.C.U. (CRP-66AFL Antenna Only)


DIMENSIONS IN INCHES
DO NOT SCALE PRINT
ANTENNA ASSEMBLY
CRP-66AGE
E508
E506
E507
MHFA 19
11 ACTIVE
CABLE I
JUNCTION BOX CRP-62108
E1307
E1308
E1309
E1306
E1310
THFA 9
2 ACTIVE
CABLE III
CASSF-50-1A
CABLE II
RESONANCE CHAMBER CRP-14AAN
IFF CONTROL UNIT CRP-23ADD
E1201
E1202
FHFA-3
2 ACTIVE
TO (IND)
FHFA 3
TO IFF
OPTIONAL CONNECTION
FHFA-3
2 OR 3 ACTIVE
TO IFF
FHFA 3
2 ACTIVE
TO IFF
CABLE IV
MHFA 14
9 ACTIVE
RADAR TRANSMITTER-RECEIVER
CRP43ABY-[RECEIVER† CRP-46ACA-1]
P301
CABLE V
CASSF-70-1A
B
RMA-10-A
CABLE VI
MHFA-19
15 ACTIVE CABLE VII
RECTIFIER POWER UNIT
CRP-20225
E201
E202
E203
E204
E205
PLAN POSITION INDICATOR
CRP-55ADQ
P401
CABLE VIII
CASSF-70-1A
TO IFF
MHFA-19
14 ACTIVE CABLE IX
MHFA-14
9 ACTIVE CABLE X
TO IFF
B
A
C
*MOTOR-ALTERNATOR & SPARK GAP ASSEMBLY
CRP-21ACD
E115
E113
E112
FHFA-3 CABLE XI
3 ACTIVE
THFA-23
2 ACTIVE
CABLE XII
MHFA-7
6 ACTIVE
CABLE XIII
STOP - START BUTTON
CBZ-24216
MAGNETIC CONTROLLER
CDD-211045
E116
E117
NAVY SWITCH
115V
DC
DHFA-23
CABLE XIV
CONFIDENTIAL

CABLE USED	TERMINAL TUBE
THFA -9	G
THFA -23	J
FHFA-3	C
MHFA-7	G
MHFA-10	J
MHFA-14	K
MHFA-19	L
CASSF-50-1A	B
CASSF-70-1A	B
RMA-10A	C

*ASSEMBLY CRP-21ACD CONSISTS OF NAVY TYPE CLL-211043 MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-1 CONSISTS OF NAVY TYPE CNH-211043A MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-2 CONSISTS OF NAVY TYPE CGU-211043B MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-3 CONSISTS OF NAVY TYPE CQR-211044 MOTOR ALTERNATOR & CRP-10211 SPARK GAP

†WITH RECEIVER CRP-46ACA CONNECT CABLE V TO D ON P401

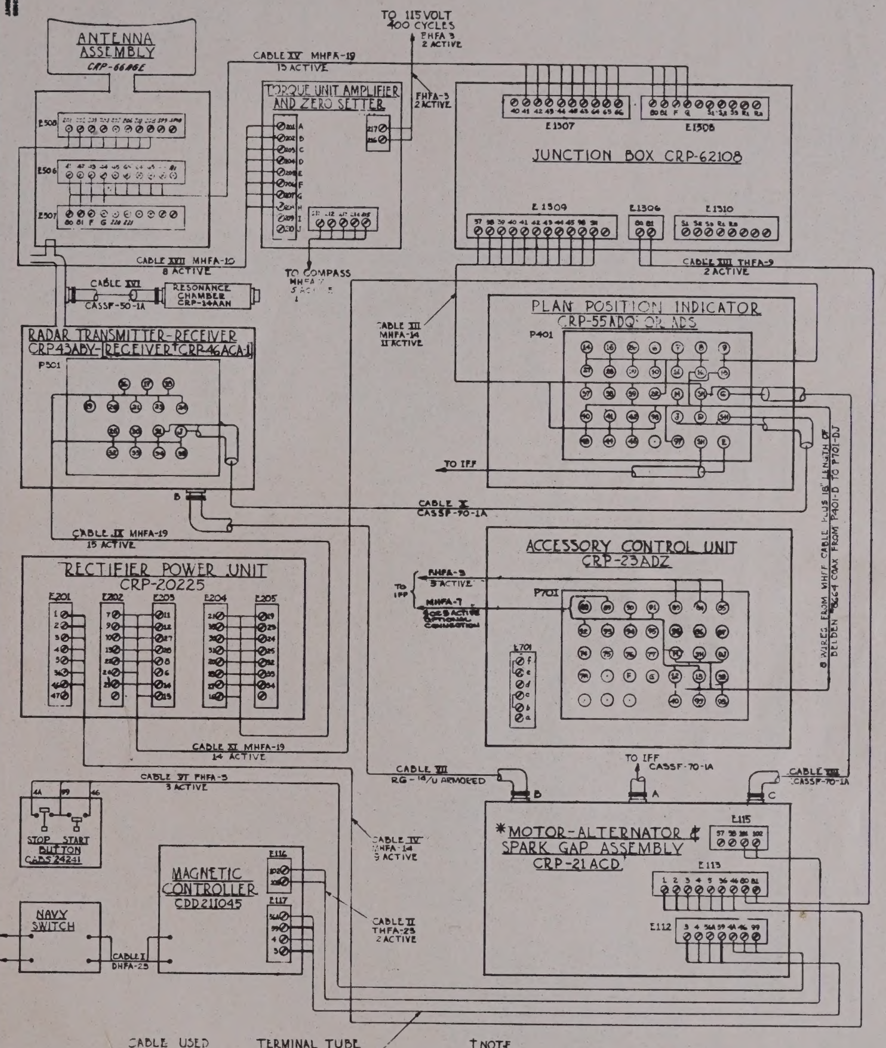
REFER TO FOLLOWING WIRING DIAGRAMS

MAGNETIC CONTROLLER	W-4D-L117
RECTIFIER POWER UNIT	W-4F-V1
MOTOR ALT. & MODULATOR ASS'Y	W-4D-W132
RADAR TRANSMITTER RECEIVER	W-4B-U2
RADAR RECEIVER	W-4B2-V5
PP INDICATOR	W-3C-W325

EXTERNAL CABLING
FIRST USED ON PRELIMINARY MODEL SO-1 RADAR
DR. P. J. CONNELLY
DATE 8-3-43
APP. 7. R.O. 9/2/43
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4-W6
A

SPEC. NO.	GR.	MAT.	SR. NO.	REF.	PT.	DESCRIPTION
	5					
	4					
	3					
	2					
	1					

Model SO-1 — W-4-W6 sub A External Cabling (CRP-66AGE Antenna Only)


TO 115 VOLT 400 CYCLES
FHFA 3 2 ACTIVE
ANTENNA ASSEMBLY CRP-66AGE
CABLE XV MHFA-19 15 ACTIVE
TORQUE UNIT AMPLIFIER AND ZERO SETTER
FHFA-3 2 ACTIVE
E508
E506
E507
E1307
E1308
JUNCTION BOX CRP-62108
E1309
E1306
E1310
CABLE XVII MHFA-10 8 ACTIVE
CABLE XVI CASSF-50-1A
RESONANCE CHAMBER CRP-14AAN
TO COMPASS MHFA
CABLE XIII THFA-9 2 ACTIVE
CABLE III MHFA-14 11 ACTIVE
PLAN POSITION INDICATOR CRP-55ADQ OR ADS
P401
RADAR TRANSMITTER-RECEIVER CRP43ABY-[RECEIVER†CRP-46ACA-1]
P301
TO IFF
B
CABLE X CASSF-70-1A
CABLE IX MHFA-19 15 ACTIVE
8 WIRES FROM WHIFF CABLE PLUS 18" LENGTH OF BELDEN #8664 COAX FROM P401-D TO P701-DJ
ACCESSORY CONTROL UNIT CRP-23ADZ
TO IFF
FHFA-3 3 ACTIVE
MHFA-7 6 ACTIVE OPTIONAL CONNECTION
P701
E701
RECTIFIER POWER UNIT CRP-20225
E201
E202
E203
E204
E205
CABLE XI MHFA-19 14 ACTIVE
CABLE VII RG-14/U ARMORED
TO IFF CASSF-70-1A
CABLE VIII CASSF-70-1A
CABLE VI FHFA-3 3 ACTIVE
B
A
C
4A
99
46
STOP START BUTTON CABS 24241
CABLE IV MHFA-14 9 ACTIVE
E115
*MOTOR-ALTERNATOR & SPARK GAP ASSEMBLY CRP-21ACD
E113
MAGNETIC CONTROLLER CDD211045
E116
E117
CABLE II THFA-23 2 ACTIVE
E112
NAVY SWITCH
CABLE I DHFA-23
CABLE III MHFA-7 6 ACTIVE

CABLE USED	TERMINAL TUBE
THFA-9	G
DHFA-23	J
FHFA-3	C
MHFA-7	G
MHFA-10	J
MHFA-14	K
MHFA-19	L
CASSF-50-1A	B OR C
CASSF-70-1A	B OR C
RG-14/U ARMORED	C

†NOTE

WITH RECEIVER CRP-46ACA CONNECT AS FOLLOWS:
J303 TO TERMINAL J ON P301
TERMINAL J TO TERMINAL D ON P401
TERMINAL DJ ON P701 TO TERMINAL J ON P401
JUMPER DJ ON P701 TO TERMINAL J ON P701
USE EXTERNAL CABLING DIAGRAM W-4-W4 WHEN TRUE BEARING AND ACCESSORY CONTROL UNITS ARE NOT USED.

*ASSEMBLY CRP-21ACD CONSISTS OF NAVY TYPE CLL-211043 MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-1 CONSISTS OF NAVY TYPE CLL-211043A MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-2 CONSISTS OF NAVY TYPE CLL-211043B MOTOR ALTERNATOR & CRP-10212 SPARK GAP
ASSEMBLY CRP-21ACD-3 CONSISTS OF NAVY TYPE CLL-211044 MOTOR ALTERNATOR & CRP-10211 SPARK GAP

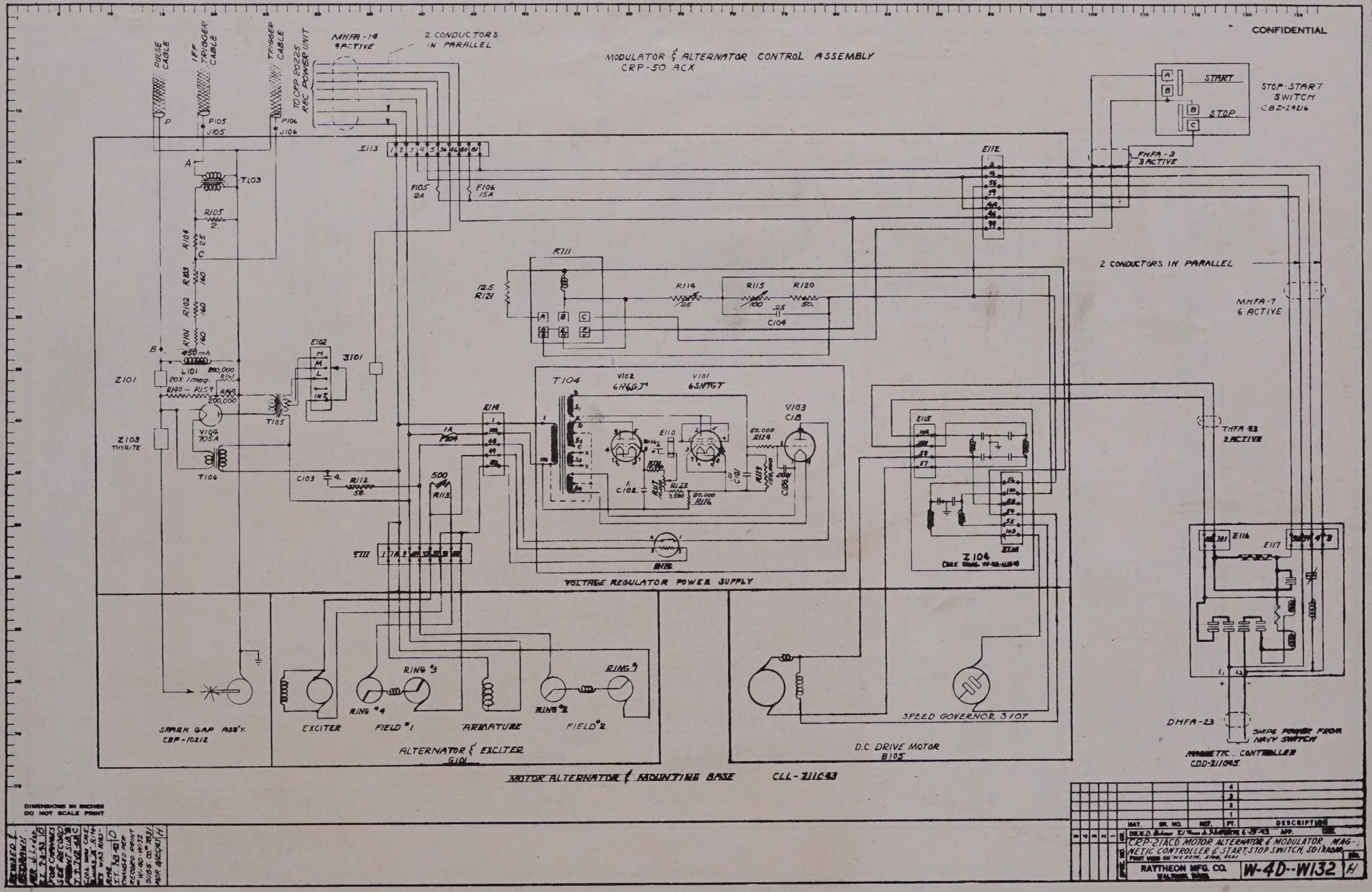
REFER TO FOLLOWING WIRING DIAGRAMS
MAGNETIC CONTROLLER — W-4D-L117
RECTIFIER POWER UNIT — W-4F-V1
MOTOR ALT. & MODULATOR ASS'Y — W-4D-W132
RADAR TRANSMITTER-RECEIVER — W-4B-U2
RADAR RECEIVER — W-4B2-V5
PP INDICATOR — W-3C-W328
ACCESSORY CONTROL UNIT — W-3K22-W204
TORQUE UNIT AMP. & ZERO SETTER —

EXTERNAL CABLING-SO-1 RADAR
FIRST USED ON (W.X. 1021)
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4-W5
A

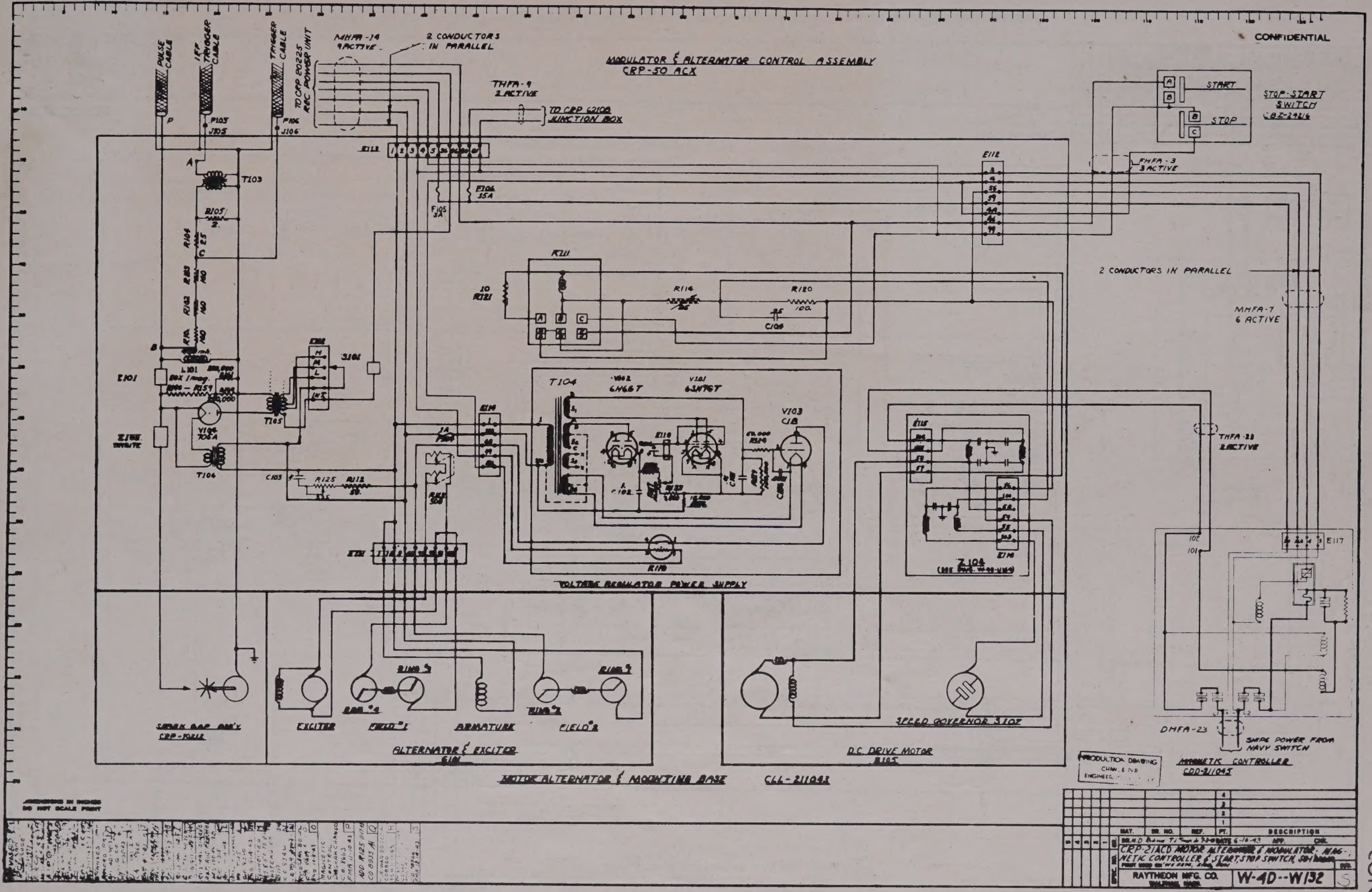
SPEC. NO. | GR. | MAT. | SR. NO. | REF. | PT. | DESCRIPTION | DATE

CONFIDENTIAL

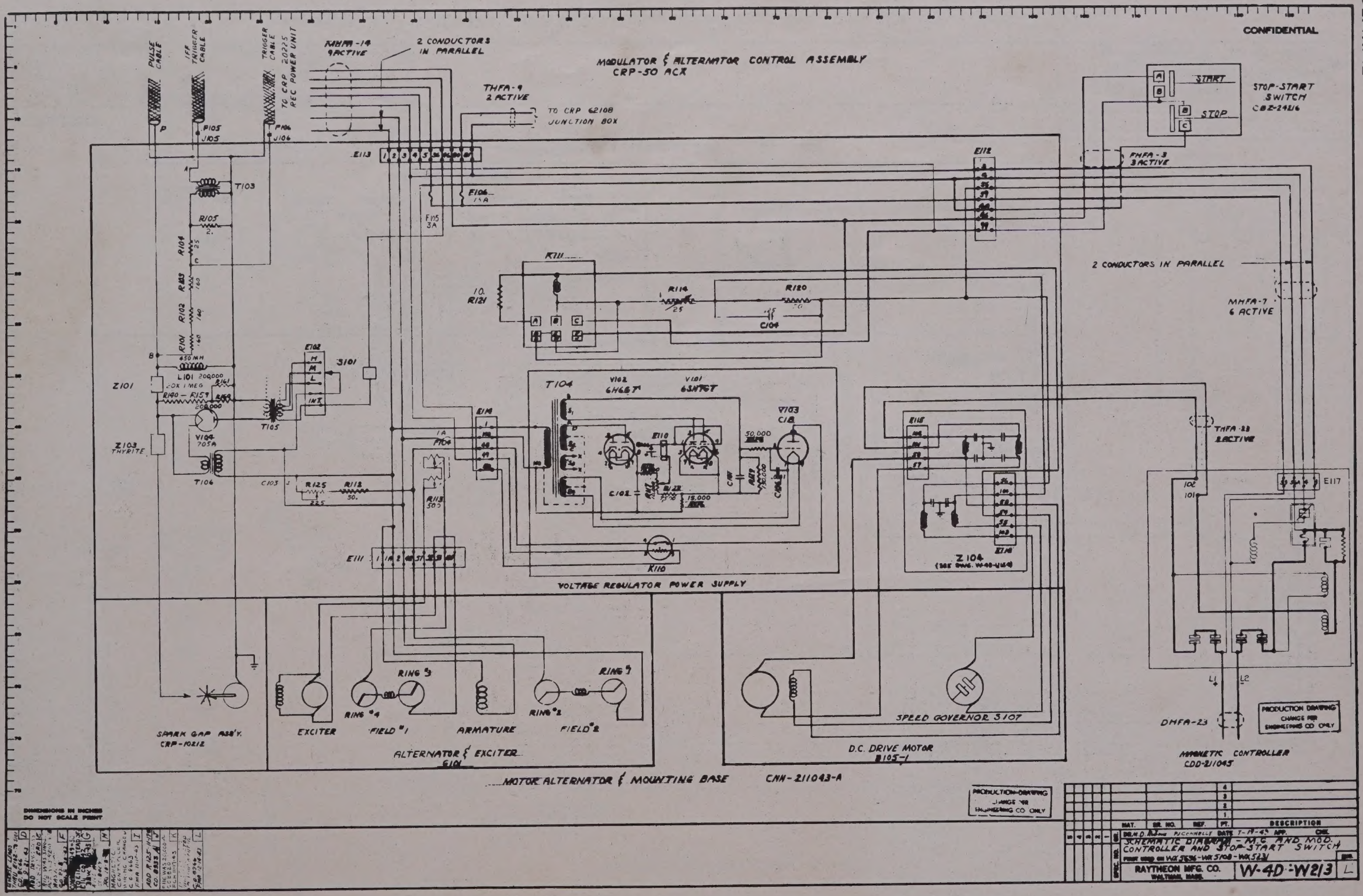
Model SO-1 — W-4-W5 sub A External Cabling Including True Bearing and A.C.U. (CRP-66AGE Antenna Only)


CONFIDENTIAL
MODULATOR & ALTERNATOR CONTROL ASSEMBLY
CRP-50 ACX
PULSE CABLE
P
IFF TRIGGER CABLE
P105
J105
TRIGGER CABLE
P106
J106
TO CRP 20225 REC POWER UNIT
MHFA-14 9 ACTIVE
2 CONDUCTORS IN PARALLEL
E113
F105 2A
F106 15A
A
T103
R105 2.
R104 25
C
R103 160
R102 160
R101 160
B
450 mh.
L101 20X
1 meg.
200,000 R161
R140 – R159
R160 200,000
Z101
Z103 THYRITE
V104 705A
T105
T106
E102
H
M
L
INT.
S101
C103 4.
R112 50.
R111
12.5 R121
R114 25
R115 100
R120 50.
.25 C104
E114
1A F104
500 R113
E111
T104
V102 6H6GT
V101 6SN7GT
E110
V103 C1B
R116 80,000
R117
R118
R119
R123 7,500
R124 60,000
C101
C102
C105
R122
VOLTAGE REGULATOR POWER SUPPLY
E112
2 CONDUCTORS IN PARALLEL
MHFA-7 6 ACTIVE
FHFA-3 3 ACTIVE
START
STOP
A
B
B
C
STOP-START SWITCH CBZ-24216
THFA 2ACTIVE
E115
Z104
E116
E117
DHFA-23
SHIPS POWER FROM NAVY SWITCH
MAGNETIC CONTROLLER CDD-211045
SPARK GAP ASS'Y. CRP-10212
EXCITER
RING #3
RING #4
FIELD #1
ARMATURE
RING #1
RING #2
FIELD #2
ALTERNATOR & EXCITER G101
SPEED GOVERNOR S107
D.C. DRIVE MOTOR B105
MOTOR ALTERNATOR & MOUNTING BASE CLL-211043
DIMENSIONS IN INCHES
DO NOT SCALE PRINT
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
APP.
CRP-21ACD MOTOR ALTERNATOR & MODULATOR, MAGNETIC CONTROLLER & START, STOP SWITCH, SO-1 RADAR
RAYTHEON MFG. CO.
W-4D--W132
H
REVISED
FOR CHANGES SEE RECORD PRINT
CHANGED PER RECORD PRINT W-0D-W132
B
C
D
H

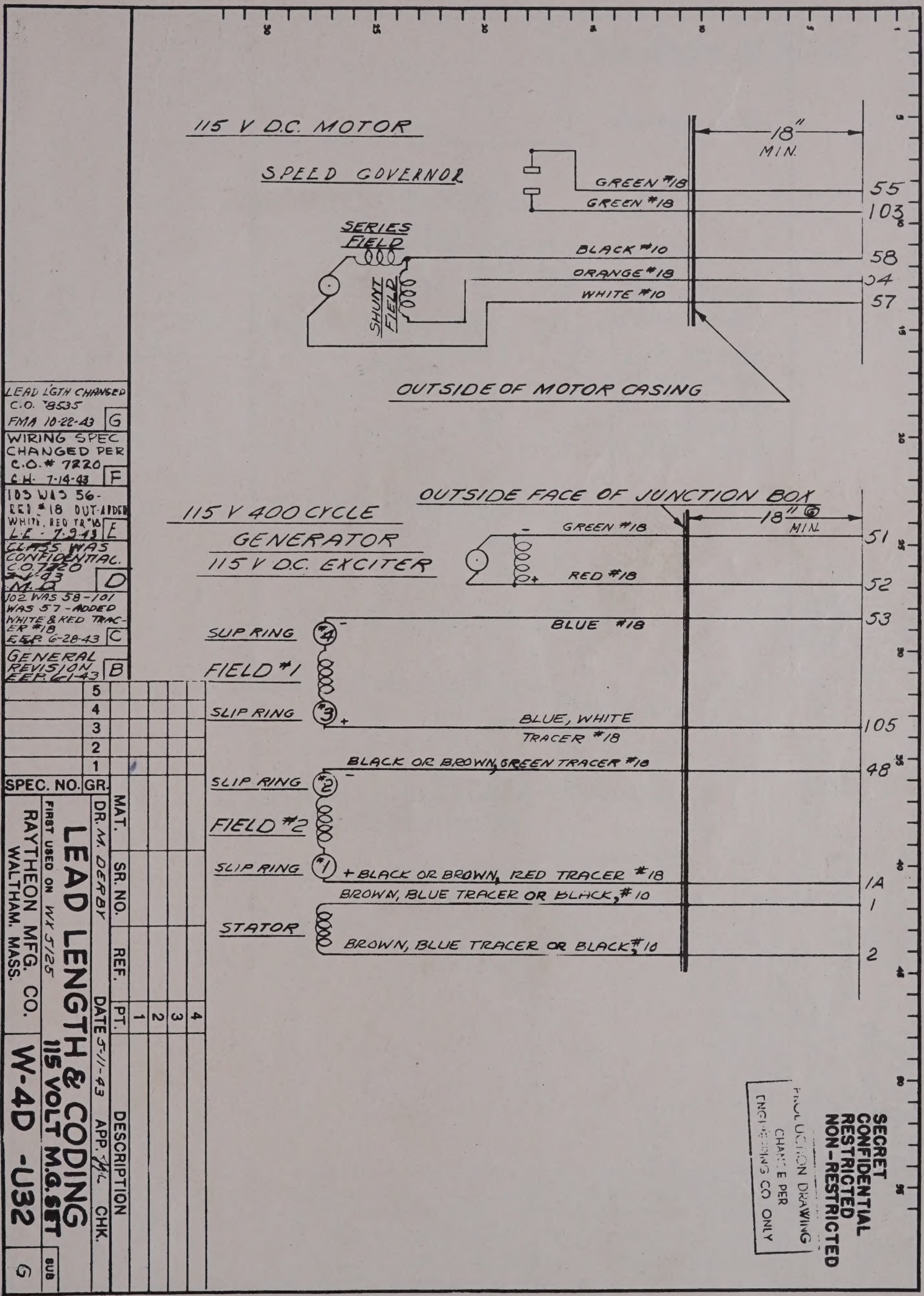
Model SO-1 — W-4D-W132 sub H Motor-Alternator-Modulator (early type)


CONFIDENTIAL
MODULATOR & ALTERNATOR CONTROL ASSEMBLY
CRP-50 ACX
PULSE CABLE
IFF TRIGGER CABLE
TRIGGER CABLE
TO CRP 20225 REC POWER UNIT
MHFA-14 9 ACTIVE
2 CONDUCTORS IN PARALLEL
THFA-9 2 ACTIVE
TO CRP 62108 JUNCTION BOX
P
P105
J105
P106
J106
E113
F106 15A
F105 3A
A
T103
R105
R104
R103
R102
R101
B
C
E101
L101
R157
V104 705A
T105
T106
E102
3101
E108 WHITE
C103
R125
R112
R111
R121
R114
R120
C106
T104
V102 6N6GT
V101 6SN7GT
V103 C1B
E110
E114
E115
E116
E112
R119
Z104
VOLTAGE REGULATOR POWER SUPPLY
START
STOP
STOP-START SWITCH CBZ-24216
FHFA-3 3 ACTIVE
2 CONDUCTORS IN PARALLEL
MHFA-7 6 ACTIVE
THFA-23 2 ACTIVE
102
101
E117
DHFA-23
SHIPS POWER FROM NAVY SWITCH
MAGNETIC CONTROLLER
CDD-211045
SPARK GAP ASS'Y
CRP-50ACX
EXCITER
FIELD 1
ARMATURE
FIELD 2
ALTERNATOR & EXCITER
G101
SPEED GOVERNOR 3107
D.C. DRIVE MOTOR
B105
MOTOR ALTERNATOR & MOUNTING BASE
CLL-211043
PRODUCTION DRAWING
CHANGE PER ENGINEERING
DIMENSIONS IN INCHES DO NOT SCALE PRINT
MAT.
DR. NO.
REF.
PT.
DESCRIPTION
DATE 6-10-43
CRP-21ACD MOTOR ALTERNATOR & MODULATOR: MAGNETIC CONTROLLER & START,STOP SWITCH, SCHEMATIC
RAYTHEON MFG. CO.
W-4D--W132
S

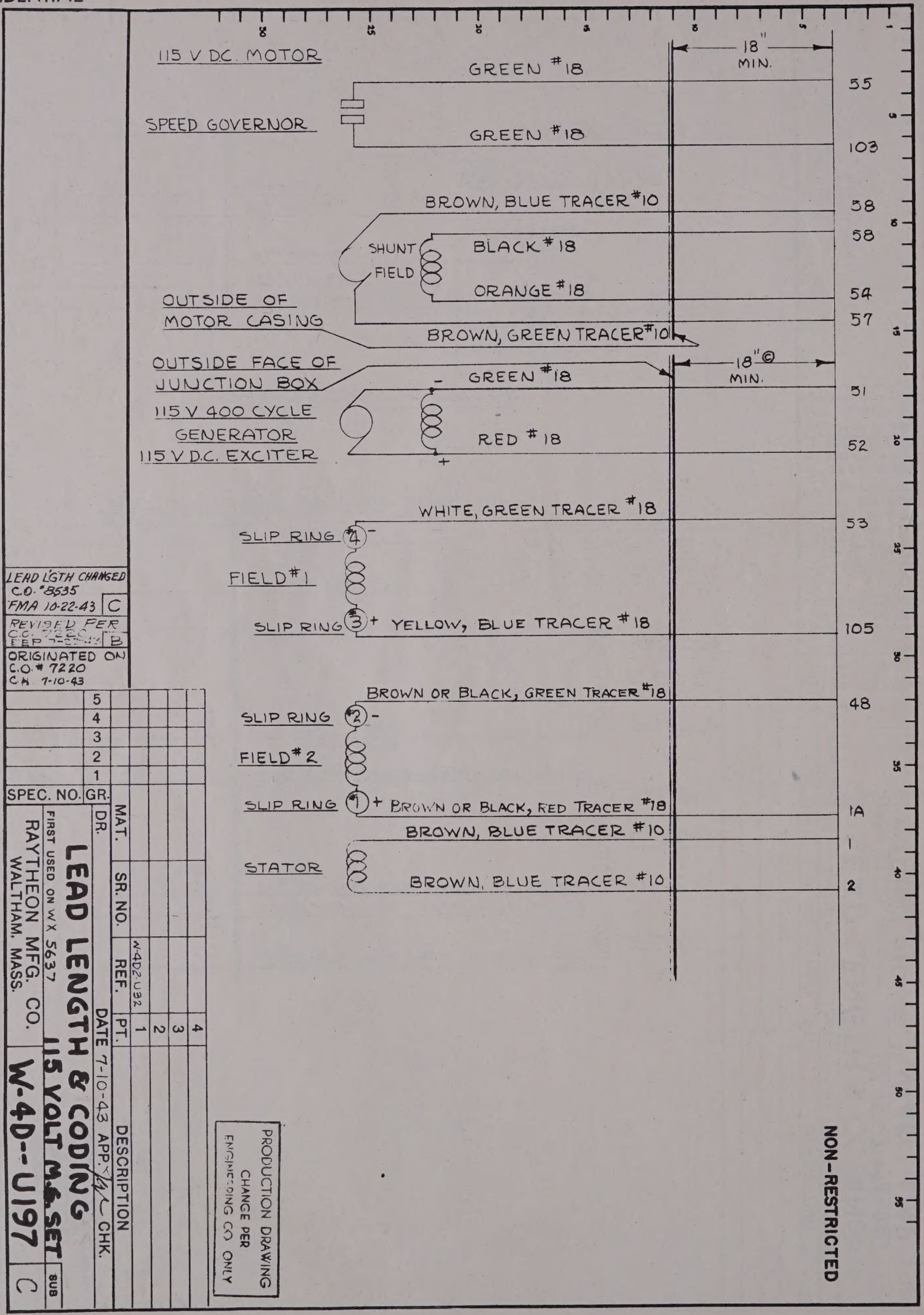
Model SO-1 — W-4D-W132 sub S Motor-Alternator-Modulator (later type using Leland Motor)


CONFIDENTIAL
PULSE CABLE
IFF TRIGGER CABLE
TRIGGER CABLE TO CRP 20225 REC POWER UNIT
P
P105
J105
P106
J106
MHFA-14 9 ACTIVE
2 CONDUCTORS IN PARALLEL
MODULATOR & ALTERNATOR CONTROL ASSEMBLY CRP-50 ACX
THFA-9 2 ACTIVE
TO CRP 62108 JUNCTION BOX
E113
F106 1.5A
F105 3A
E112
FHFA-3 3 ACTIVE
STOP-START SWITCH CBZ-24216
START
STOP
A
B
C
2 CONDUCTORS IN PARALLEL
MHFA-7 6 ACTIVE
T103
R105 2.
R104 25
R103 160
R102 160
R101 160
B
650 MH
L101 200,000
20K 1 MEG
R140 – R157
R141
R158
200,000
Z101
Z103 THYRITE
V104 705A
T105
T106
E102
H
M
L
INT
S101
R111
10. R121
R114 25
R120
C104
T104
V102 6H6GT
V101 6SN7GT
V103 C1B
E110
50,000
15,000
C102
C103
R125 225
R112 50.
R113 500
1A F104
E114
E111
K110
VOLTAGE REGULATOR POWER SUPPLY
E115
E116
Z104 (SEE DWG. W-40-U114)
THFA-22 2 ACTIVE
102
101
E117
L1
L2
DHFA-23
MAGNETIC CONTROLLER CDD-211045
PRODUCTION DRAWING CHANGE FOR ENGINEERING CO ONLY
SPARK GAP ASS'Y. CRP-10212
EXCITER
RING #3
RING #4
FIELD #1
ARMATURE
RING #2
RING #1
FIELD #2
ALTERNATOR & EXCITER G101
SPEED GOVERNOR S107
D.C. DRIVE MOTOR B105-1
MOTOR ALTERNATOR & MOUNTING BASE
CNH-211043-A
DIMENSIONS IN INCHES DO NOT SCALE PRINT
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
DATE 7-19-43
APP.
CHK.
SCHEMATIC DIAGRAM – M.G. AND MOD. CONTROLLER AND STOP-START SWITCH
RAYTHEON MFG. CO. WALTHAM, MASS.
W-4D-W213
L

Model SO-1 — W-4D-W213 sub L Motor-Alternator-Modulator (using Murray Motor)

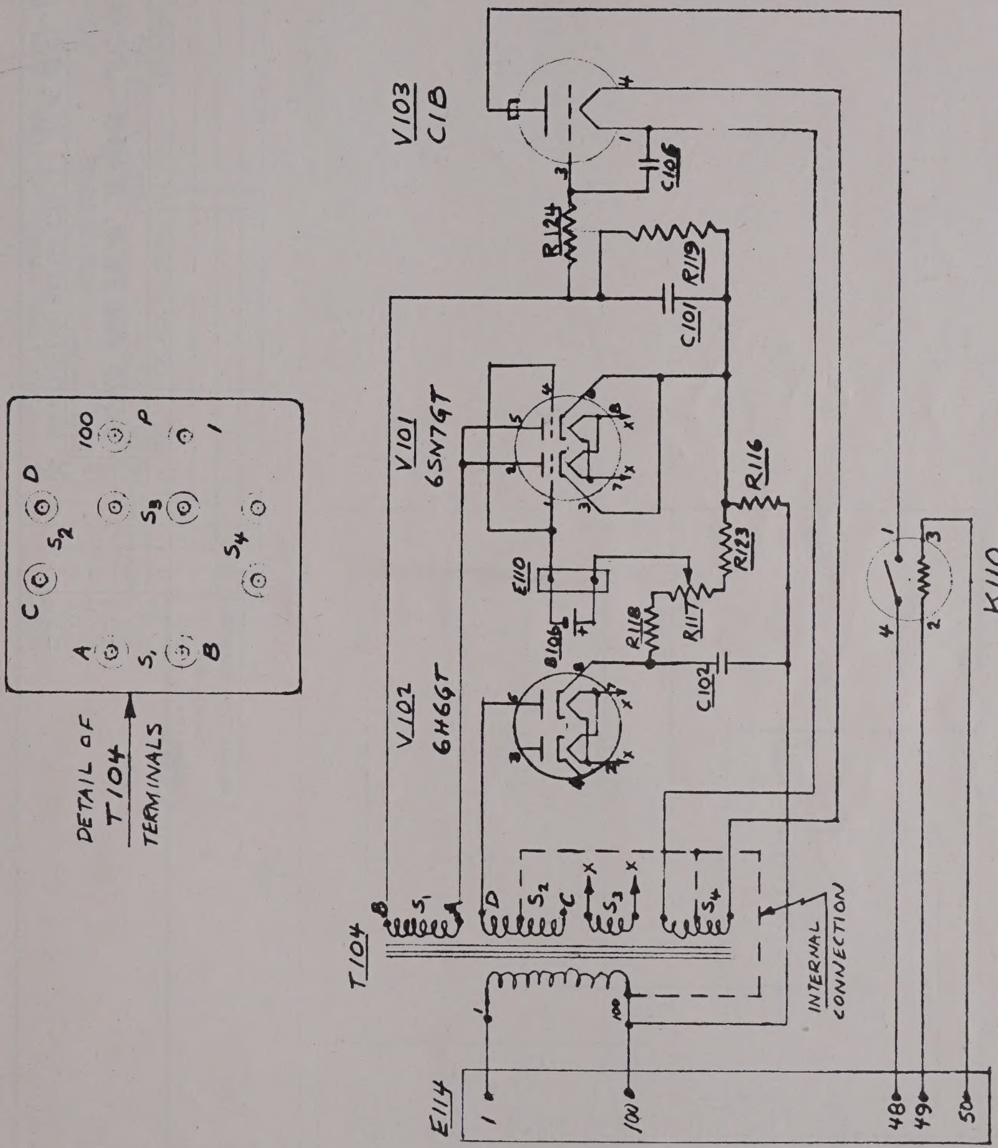

115 V D.C. MOTOR
SPEED GOVERNOR
GREEN #18
GREEN #18
SERIES FIELD
SHUNT FIELD
BLACK #10
ORANGE #18
WHITE #10
18" MIN.
55
103
58
104
57
OUTSIDE OF MOTOR CASING
OUTSIDE FACE OF JUNCTION BOX
115 V 400 CYCLE GENERATOR
115 V D.C. EXCITER
GREEN #18
RED #18
18" MIN.
51
52
SLIP RING #4
BLUE #18
53
FIELD #1
SLIP RING #3
BLUE, WHITE TRACER #18
105
BLACK OR BROWN, GREEN TRACER #18
48
SLIP RING #2
FIELD #2
SLIP RING #1
BLACK OR BROWN, RED TRACER #18
1A
BROWN, BLUE TRACER OR BLACK, #10
1
STATOR
BROWN, BLUE TRACER OR BLACK, #10
2
LEAD LGTH CHANGED C.O. 8535 FMA 10-22-43 G
WIRING SPEC CHANGED PER C.O.# 7220 C.H. 7-14-43 F
103 WAS 56- RED #18 OUT-ADDED WHITE, RED TR #18 L.E. 7-9-43 E
CLASS WAS CONFIDENTIAL C.O.7220 7-1-43 M.D. D
102 WAS 58-101 WAS 57-ADDED WHITE & RED TRACER #18 E.E.P. 6-28-43 C
GENERAL REVISION E.E.P. 6-1-43 B
SPEC. NO.
GR.
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
DR. M. DERBY
DATE 5-11-43
APP.
CHK.
LEAD LENGTH & CODING
115 VOLT M.G. SET
FIRST USED ON WX 5125
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4D-U32
SUB
G
SECRET
CONFIDENTIAL
RESTRICTED
NON-RESTRICTED
PRODUCTION DRAWING
CHANGE PER
ENGINEERING CO ONLY

Model SO-1 — W-4D-U32 sub G Leland Motor-Alternator: Color Coding


115 V D.C. MOTOR
SPEED GOVERNOR
GREEN #18
55
GREEN #18
103
BROWN, BLUE TRACER #10
58
SHUNT
FIELD
BLACK #18
58
ORANGE #18
54
OUTSIDE OF MOTOR CASING
57
BROWN, GREEN TRACER #10
18" MIN.
OUTSIDE FACE OF JUNCTION BOX
18" © MIN.
GREEN #18
51
115 V 400 CYCLE GENERATOR
115 V D.C. EXCITER
RED #18
52
WHITE, GREEN TRACER #18
53
SLIP RING 4
FIELD #1
SLIP RING 3
YELLOW, BLUE TRACER #18
105
BROWN OR BLACK, GREEN TRACER #18
48
SLIP RING 2
FIELD #2
SLIP RING 1
BROWN OR BLACK, RED TRACER #18
1A
BROWN, BLUE TRACER #10
1
STATOR
BROWN, BLUE TRACER #10
2
LEAD LGTH CHANGED C.O. #8535 FMA 10-22-43 C
REVISED PER C.O. FEB B
ORIGINATED ON C.O. # 7220 C.H. 7-10-43
5
4
3
2
1
SPEC. NO.
GR.
MAT.
SR. NO.
REF.
PT.
W-4D2-U32
1
2
3
4
DESCRIPTION
DR.
DATE 7-10-43
APP.
CHK.
LEAD LENGTH & CODING
115 VOLT M.G. SET
FIRST USED ON WX 5637
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4D--U197
SUB
C
PRODUCTION DRAWING
CHANGE PER
ENGINEERING CO. ONLY
NON-RESTRICTED

Model SO-1 — W-4D-U197 sub C Murray Motor-Alternator: Color Coding

CONFIDENTIAL


V103
C1B
V101
6SN7GT
V102
6H6GT
R124
C106
R119
C101
R116
R123
R117
R118
E110
B106
C102
K110
T104
S1
S2
S3
S4
A
B
C
D
P
100
1
INTERNAL CONNECTION
E114
48
49
50
DETAIL OF T104 TERMINALS

DR. J G LODER DATE 6-22-43 APP. JGL CHK.

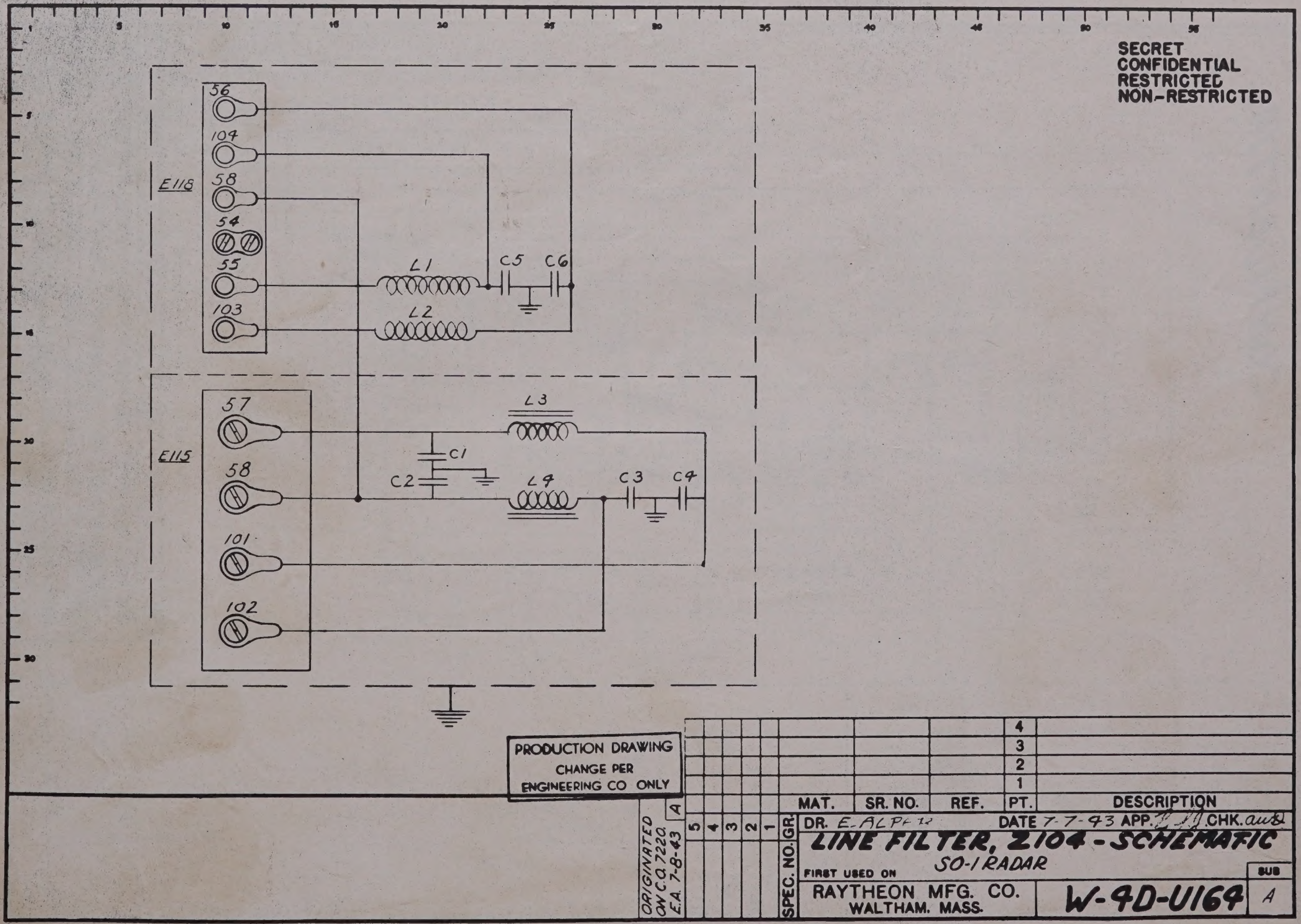
SCHEMATIC DIAGRAM — VOLTAGE REGULATOR POWER SUPPLY

FIRST USED ON WX-3527-A (SUB OF WX-5301) SUB

RAYTHEON MFG. CO.
WALTHAM. MASS.

W-4D-L151 E

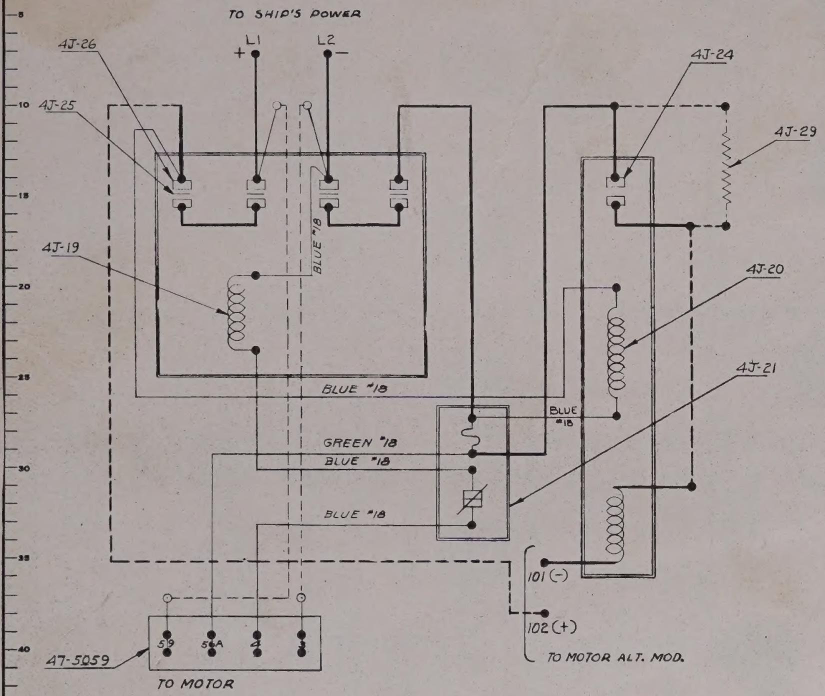
Model SO-1 — W-4D-L151 sub E Motor-Alternator: Voltage Regulator


SECRET
CONFIDENTIAL
RESTRICTED
NON-RESTRICTED
E118
56
104
58
54
55
103
L1
L2
C5
C6
E115
57
58
101
102
L3
L4
C1
C2
C3
C4
PRODUCTION DRAWING
CHANGE PER
ENGINEERING CO ONLY
ORIGINATED
ON C.O. 7220
E.A. 7-8-43
A
5
4
3
2
1
GR.
SPEC. NO.
4
3
2
1
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
DR. E. ALPF 12
DATE 7-7-43 APP.
CHK.
LINE FILTER, Z104 - SCHEMATIC
FIRST USED ON
SO-1 RADAR
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4D-U164
SUB
A

Model SO-1 — W-4D-U164 sub A Motor-Alternator: Z-104 Noise Filter

CONFIDENTIAL

NON-RESTRICTED


TO SHIP'S POWER
L1
+
L2
−
4J-26
4J-25
4J-19
4J-24
4J-29
4J-20
4J-21
BLUE #18
BLUE #18
BLUE #18
GREEN #18
BLUE #18
BLUE #18
101 (−)
102 (+)
TO MOTOR ALT. MOD.
59
59A
4
3
47-5059
TO MOTOR

NOTES-

1- ALL WIRING IS ROCKBESTOS #10 MULTISTRAND OR #10 GRAY DENSHEATH EXCEPT WHEN OTHERWISE SPECIFIED, IN WHICH CASE AIRCRAFT WIRE IS REQUIRED

2- DOTTED LEADS ARE INSTALLED BEHIND PANEL

3- SMALL CIRCLES ARE HOLES IN PANEL

4- DOTS ARE TIE POINTS OR TERMINALS

5- NUMBERS ARE STORES NO'S AS FOLLOWS:-

STORES NO.	DESCRIPTION	SYMBOL DESIG	QUANTITY PER SET
4J-21	OVERLOAD RELAY ASSY.	K112	1
4J-19	OPERATING COIL CRY59	K113	1
4J-26	CONTACTS	K113 A	8
4J-25	INTERMEDIATE FINGERS	K113 B	4
4J-22	SPRINGS	K113 C	5
4J-20	ACCEL. COIL CRY 188	K114	1
4J-24	CONTACTS	K114 A	2
4J-23	SPRING	K114 B	1
47-5059	TERMINAL STRIP	E117	1
4J-29	STARTING RESISTOR	R122	1

REDRAWN
C.O. #8665
FMA 11-8-43
E

END OF 4J-20 NOW
CONNECTED TO
INPUT END OF 4J21
WAS CONNECTED
TO INPUT END OF
CURRENT COIL
CONNECTIONS TO
4J20 WERE PHYS-
ICALLY INVERTED
CO# 9184
R.M. 12-14-43
F

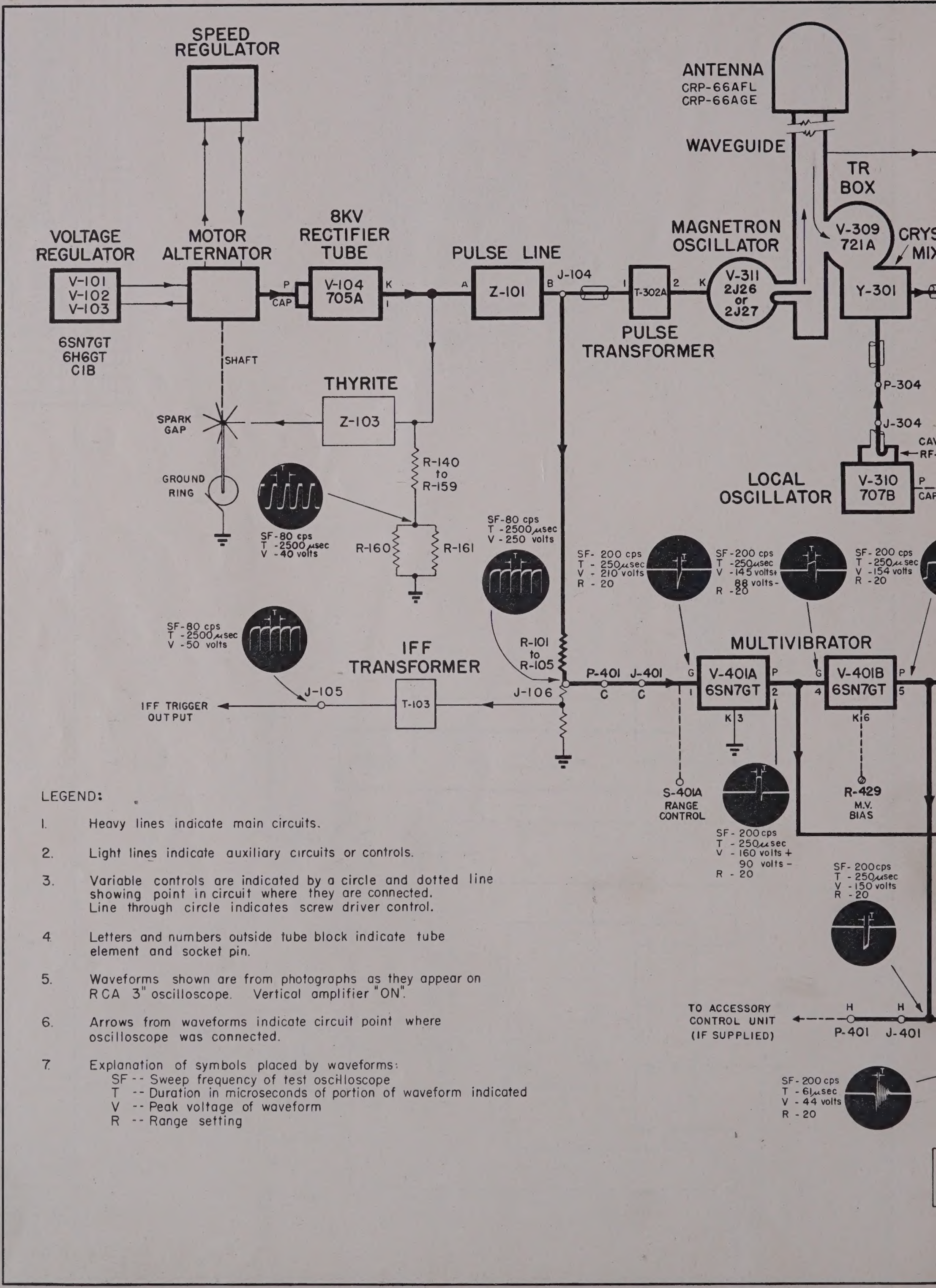
MAT.	SR. NO.	REF.	PT.
			1
			2
			3
			4

DESCRIPTION
GR. 1 2 3 4 5
DR. F.M. Aldrich DATE 11-8-43 APP. [illegible] CHK.

WIRING DIAGRAM-CONTROLLER

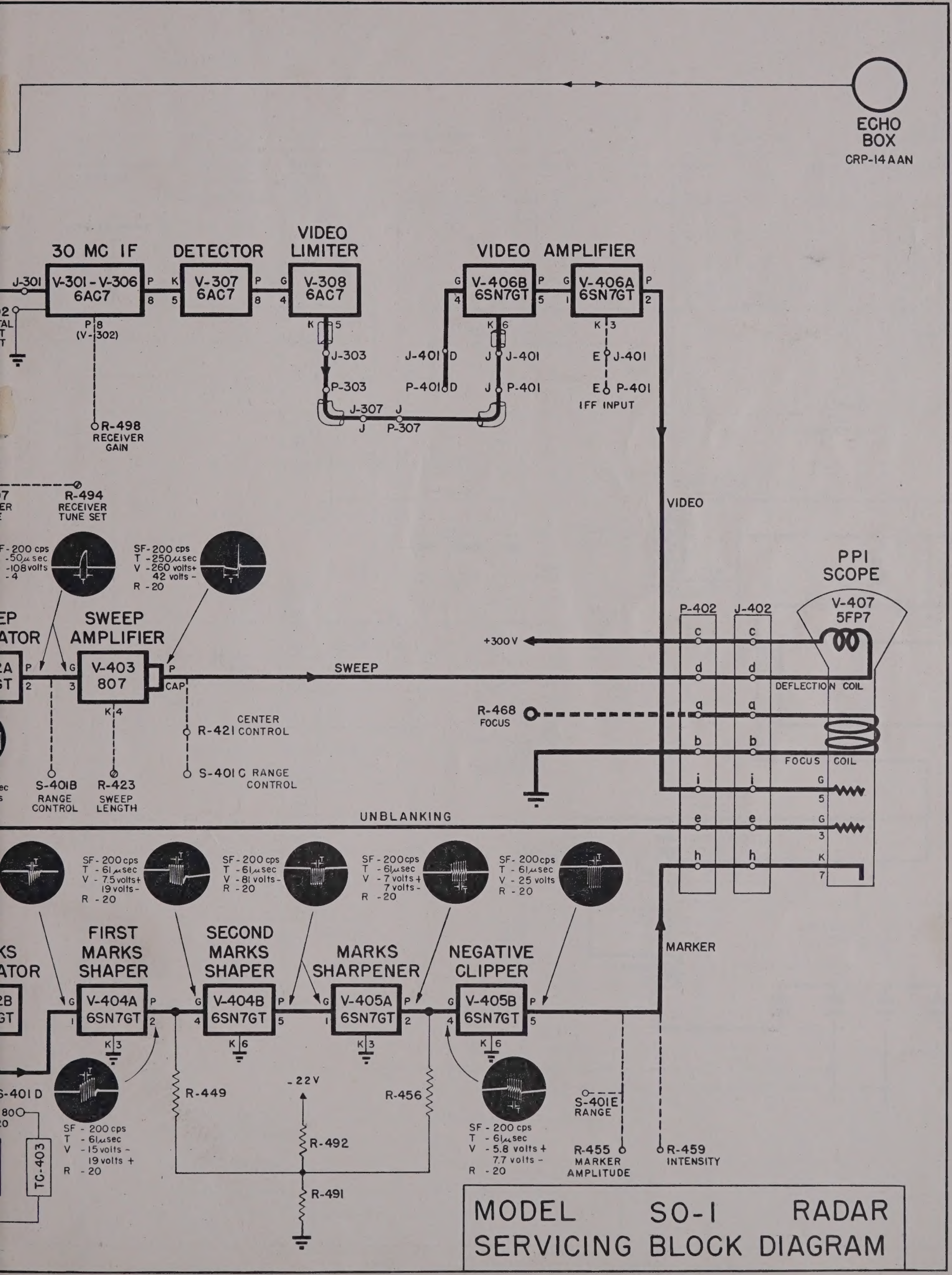
FIRST USED ON WX 510B
SPEC. NO.
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4D-V117
SUB. F

Model SO-1 — W-4D-V117 sub F Magnetic Controller

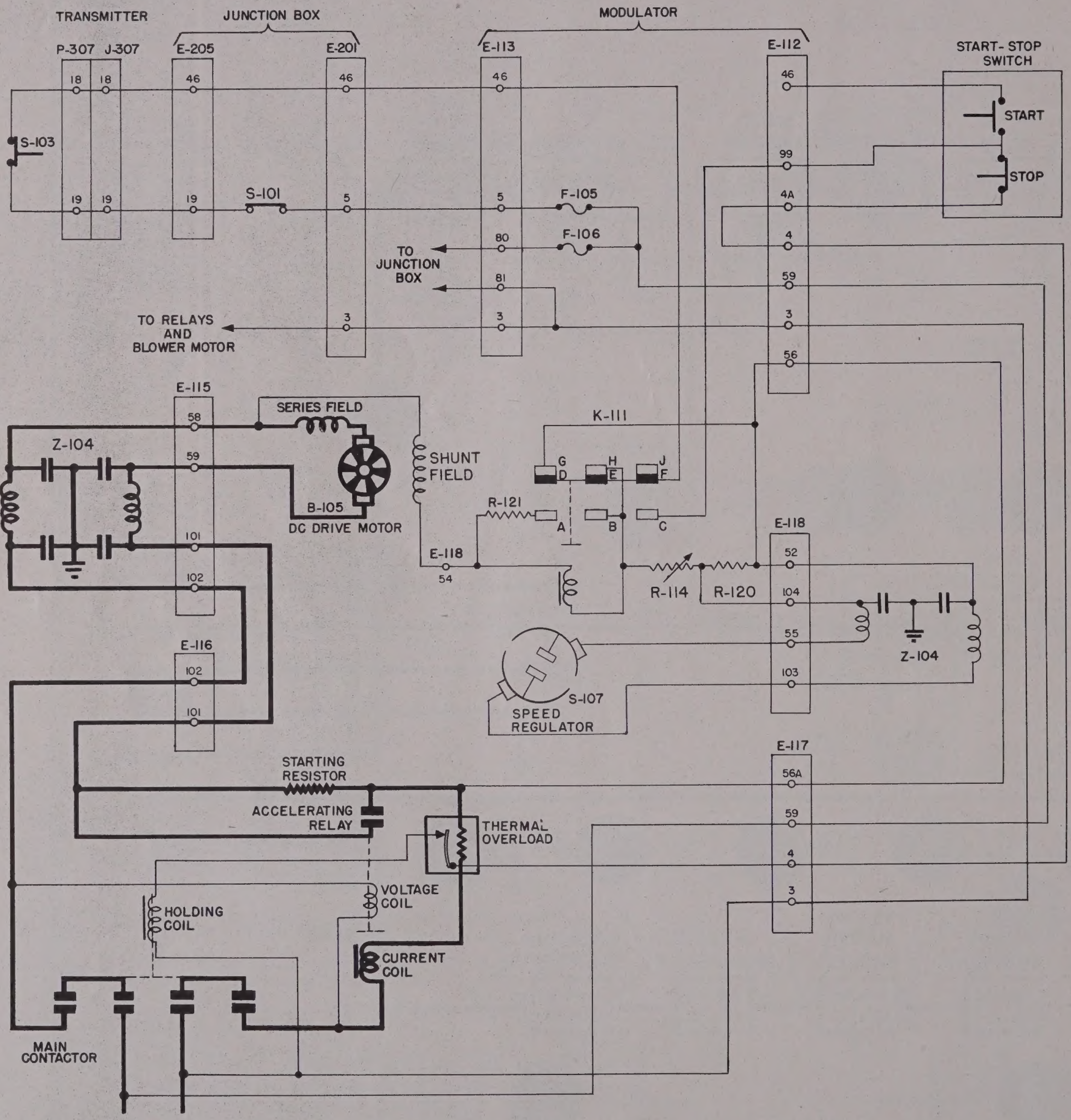

SPEED REGULATOR
VOLTAGE REGULATOR
V-101
V-102
V-103
6SN7GT
6H6GT
C1B
MOTOR ALTERNATOR
SHAFT
8KV RECTIFIER TUBE
P
CAP
V-104
705A
K
I
PULSE LINE
A
Z-101
B
J-104
1
T-302A
2
K
PULSE TRANSFORMER
MAGNETRON OSCILLATOR
V-311
2J26
or
2J27
ANTENNA
CRP-66AFL
CRP-66AGE
WAVEGUIDE
TR BOX
V-309
721A
CRYS
MIX
Y-301
P-304
J-304
CAV
RF-
LOCAL OSCILLATOR
V-310
707B
P
CAP
THYRITE
Z-103
SPARK GAP
GROUND RING
R-140
to
R-159
R-160
R-161
SF-80 cps
T -2500 μsec
V -40 volts
SF-80 cps
T -2500 μsec
V -250 volts
SF-80 cps
T -2500 μsec
V -50 volts
IFF TRANSFORMER
T-103
J-105
J-106
IFF TRIGGER OUTPUT
R-101
to
R-105
P-401
J-401
C
C
SF- 200 cps
T - 250 μsec
V - 210 volts
R - 20
SF-200 cps
T -250 μsec
V -145 volts+
88 volts-
R -20
SF- 200 cps
T -250 μsec
V -154 volts
R -20
MULTIVIBRATOR
G
V-401A
6SN7GT
P
1
2
K 3
G
4
V-401B
6SN7GT
P
5
K 6
S-401A
RANGE CONTROL
R-429
M.V. BIAS
SF- 200 cps
T - 250 μsec
V - 160 volts +
90 volts -
R - 20
SF- 200cps
T - 250 μsec
V - 150 volts
R - 20
TO ACCESSORY CONTROL UNIT (IF SUPPLIED)
H
H
P-401
J-401
SF- 200 cps
T - 61 μsec
V - 44 volts
R - 20

LEGEND:

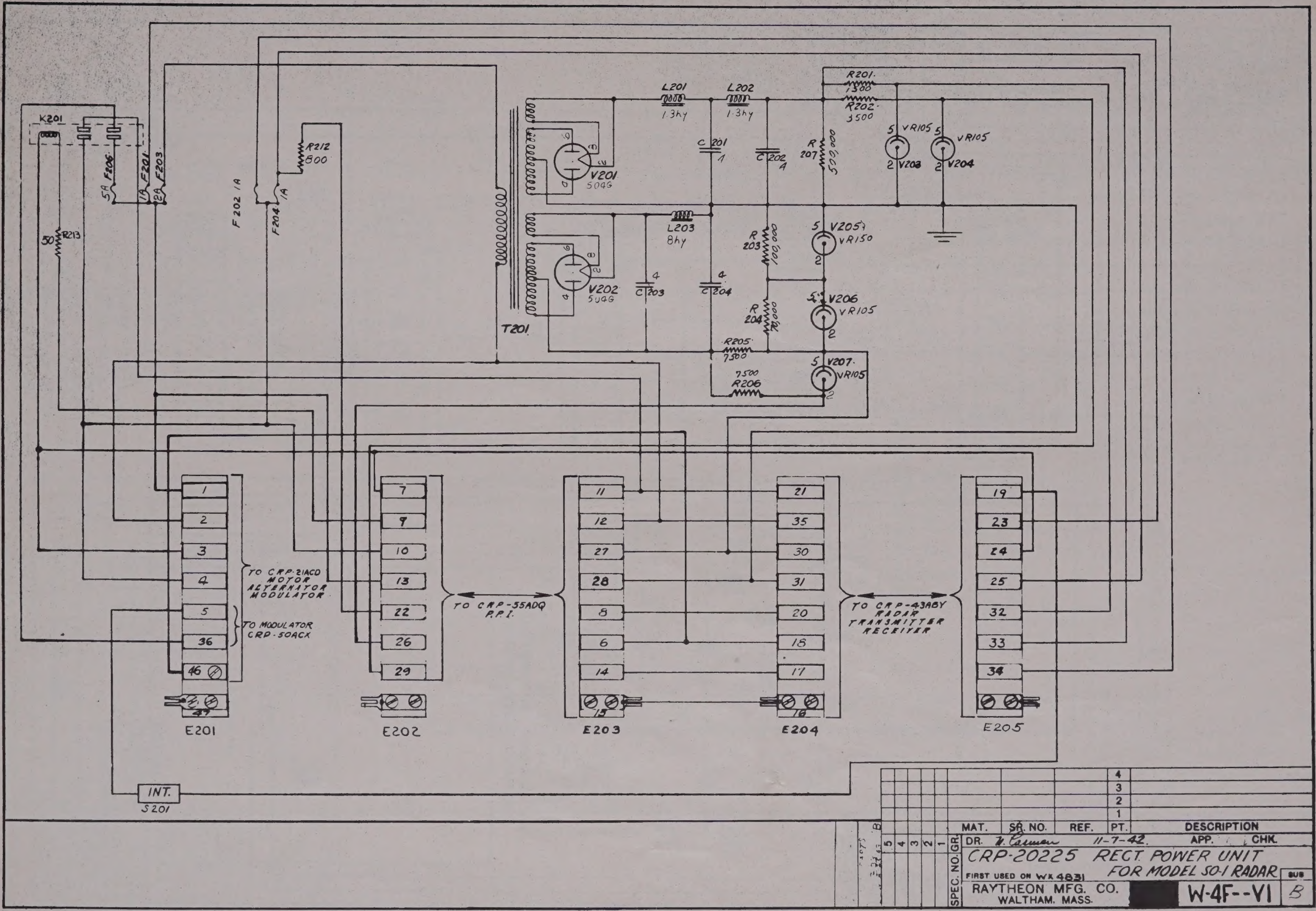
1. Heavy lines indicate main circuits.
2. Light lines indicate auxiliary circuits or controls.
3. Variable controls are indicated by a circle and dotted line showing point in circuit where they are connected. Line through circle indicates screw driver control.
4. Letters and numbers outside tube block indicate tube element and socket pin.
5. Waveforms shown are from photographs as they appear on RCA 3" oscilloscope. Vertical amplifier "ON".
6. Arrows from waveforms indicate circuit point where oscilloscope was connected.
7. Explanation of symbols placed by waveforms:
   SF -- Sweep frequency of test oscilloscope
   T -- Duration in microseconds of portion of waveform indicated
   V -- Peak voltage of waveform
   R -- Range setting


ECHO BOX
CRP-14AAN
30 MC IF
J-301
V-301 - V-306
6AC7
P 8
(V-302)
R-498
RECEIVER GAIN
DETECTOR
V-307
6AC7
VIDEO LIMITER
V-308
6AC7
J-303
P-303
J-307
P-307
VIDEO AMPLIFIER
V-406B
6SN7GT
V-406A
6SN7GT
J-401
P-401
IFF INPUT
VIDEO
R-494
RECEIVER TUNE SET
SF-200 cps
T -50μsec
V -108 volts
R -4
SF-200 cps
T -250μsec
V -260 volts+
42 volts -
R -20
SWEEP AMPLIFIER
V-403
807
CAP
SWEEP
R-421 CENTER CONTROL
S-401C RANGE CONTROL
S-401B RANGE CONTROL
R-423 SWEEP LENGTH
PPI SCOPE
V-407
5FP7
P-402
J-402
+300 V
DEFLECTION COIL
R-468 FOCUS
FOCUS COIL
UNBLANKING
SF-200cps
T - 61μsec
V - 7.5 volts+
19 volts -
R - 20
SF-200cps
T - 61μsec
V - 81 volts -
R - 20
SF-200cps
T - 61μsec
V - 7 volts +
7 volts -
R - 20
SF-200cps
T - 61μsec
V - 25 volts
R - 20
FIRST MARKS SHAPER
V-404A
6SN7GT
SECOND MARKS SHAPER
V-404B
6SN7GT
MARKS SHARPENER
V-405A
6SN7GT
NEGATIVE CLIPPER
V-405B
6SN7GT
MARKER
S-401 D
TC-403
SF - 200 cps
T - 61μsec
V - 15 volts -
19 volts +
R - 20
R-449
-22V
R-492
R-491
R-456
SF - 200 cps
T - 61μsec
V - 5.8 volts +
7.7 volts -
R - 20
S-401E RANGE
R-455 MARKER AMPLITUDE
R-459 INTENSITY

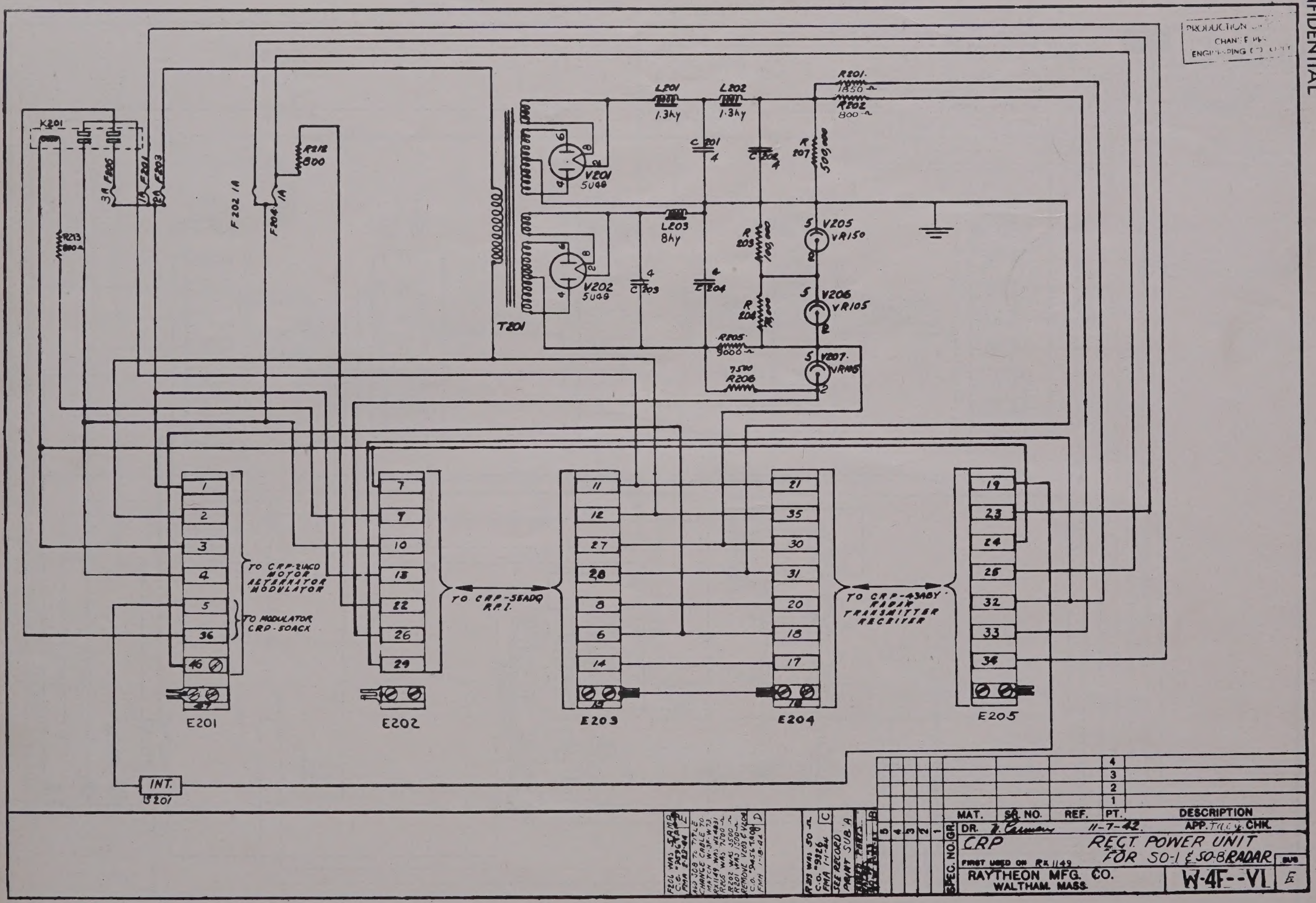
MODEL SO-1 RADAR
SERVICING BLOCK DIAGRAM


TRANSMITTER
JUNCTION BOX
MODULATOR
START- STOP SWITCH
P-307
J-307
E-205
E-201
E-113
E-112
18
19
46
5
80
81
3
99
4A
4
59
56
S-103
S-101
F-105
F-106
START
STOP
TO JUNCTION BOX
TO RELAYS AND BLOWER MOTOR
E-115
58
59
101
102
Z-104
SERIES FIELD
SHUNT FIELD
B-105
DC DRIVE MOTOR
K-111
G
H
J
D
E
F
A
B
C
R-121
E-118
54
R-114
R-120
E-118
52
104
55
103
Z-104
S-107
SPEED REGULATOR
E-116
102
101
STARTING RESISTOR
ACCELERATING RELAY
THERMAL OVERLOAD
E-117
56A
59
4
3
VOLTAGE COIL
HOLDING COIL
CURRENT COIL
MAIN CONTACTOR

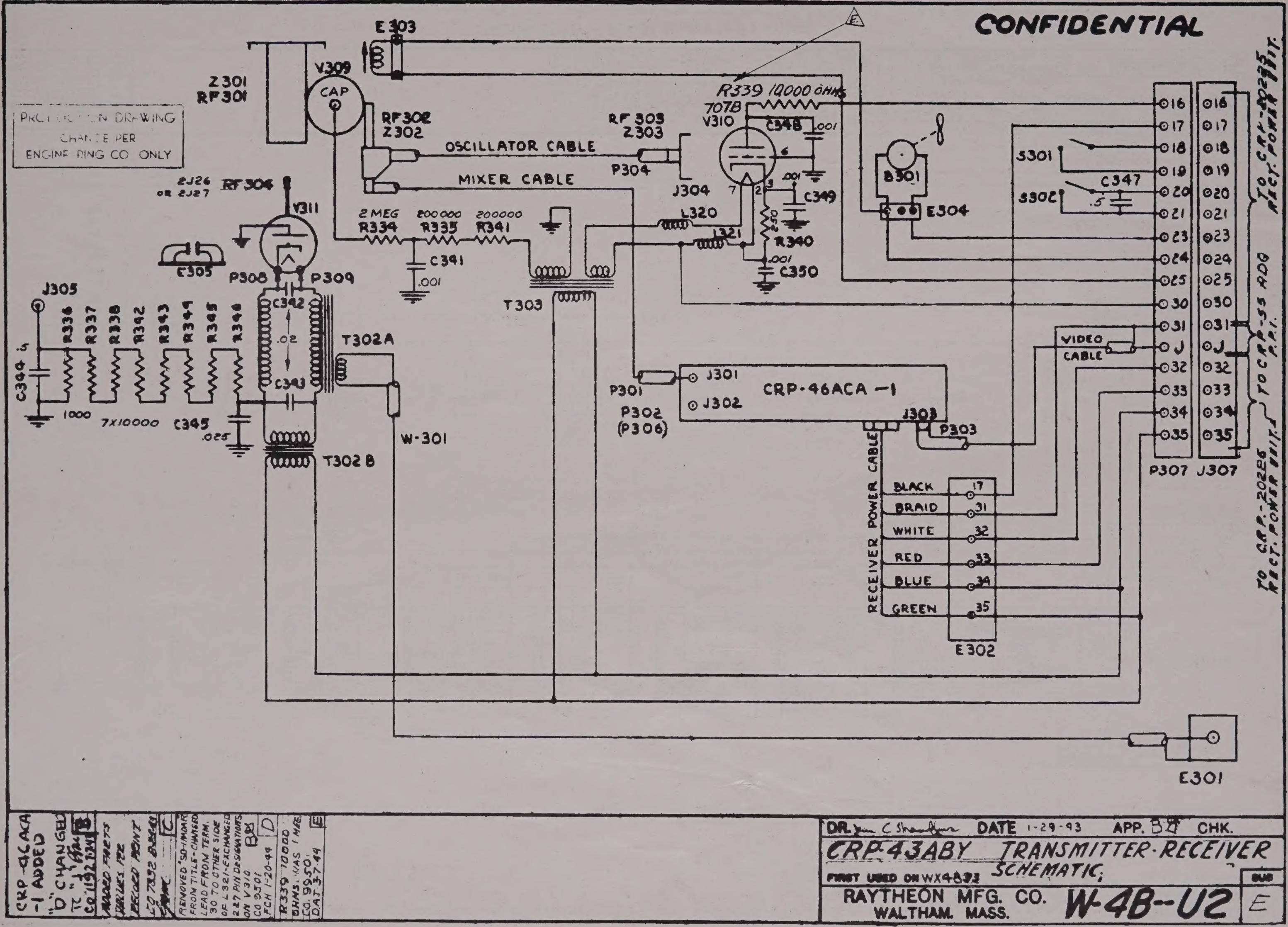
Model SO-1 — Primary D. C. Circuit


K201
5A F206
1A F201
2A F203
F 202 1A
F204 1A
R212 800
50 R213
T201
V201 5U4G
V202 5U4G
L201 1.3hy
L202 1.3hy
L203 8hy
C201 1
C202 A
4 C203
4 C204
R201 7500
R202 3500
R 207 500,000
R 203 100,000
R 204 10,000
R205 7500
7500 R206
VR105 V203
VR105 V204
V205 VR150
V206 VR105
V207 VR105
1
2
3
4
5
36
46
47
7
9
10
13
22
26
29
11
12
27
28
8
6
14
15
21
35
30
31
20
18
17
16
19
23
24
25
32
33
34
TO CRP-21ACD MOTOR ALTERNATOR MODULATOR
TO MODULATOR CRP-50ACK
TO CRP-55ADQ P.P.I.
TO CRP-43ABY RADAR TRANSMITTER RECEIVER
E201
E202
E203
E204
E205
INT.
S201
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
DR. W. Carman
11-7-42
APP.
CHK.
GR.
SPEC. NO.
CRP-20225 RECT. POWER UNIT FOR MODEL SO-1 RADAR
FIRST USED ON WX 4831
RAYTHEON MFG. CO. WALTHAM, MASS.
W-4F--V1
SUB
B

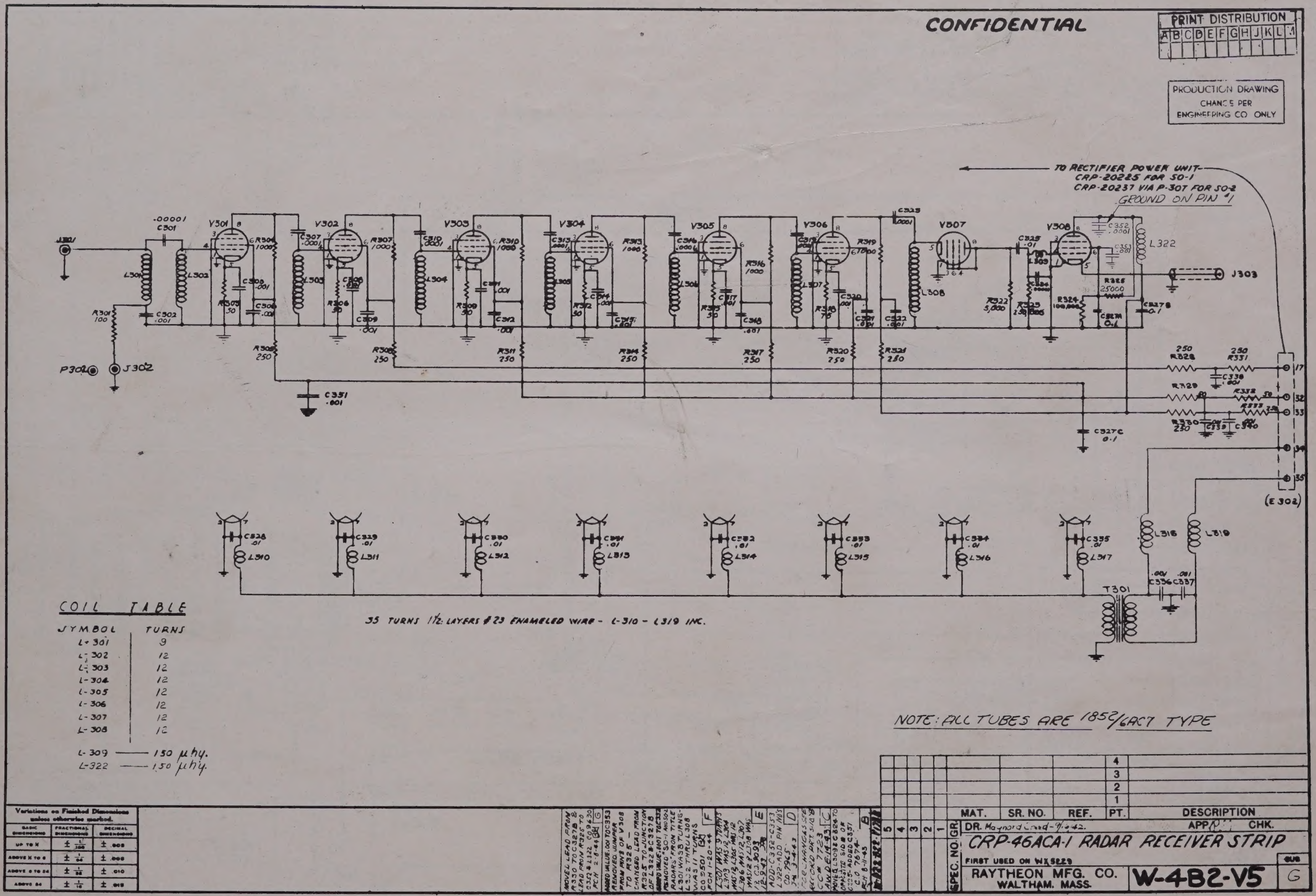
Model SO-1 — W-4F-V1 sub B Rectifier Power Unit (early type)


PRODUCTION ... CHANGE PER ENGINEERING ... UNIT
K201
R213 800
3A F205
1A F201
3A F203
F202 1A
F204 1A
R212 800
T201
V201 5U4G
V202 5U4G
L201 1.3hy
L202 1.3hy
L203 8hy
C201 4
C202 4
C203 4
C204 4
R201 1850 Ω
R202 800 Ω
R207 500 Ω
R203 100,000
R204
R205 9000 Ω
R206 7500
V205 VR150
V206 VR105
V207 VR105
TO CRP-21ACO MOTOR ALTERNATOR MODULATOR
TO MODULATOR CRP-50ACK
TO CRP-55ADQ R.P.I.
TO CRP-43ABY RADAR TRANSMITTER RECEIVER
E201
E202
E203
E204
E205
INT.
J201
1 2 3 4 5 36 46 47
7 9 10 13 22 26 29
11 12 27 28 8 6 14 15
21 35 30 31 20 18 17 16
19 23 24 25 32 33 34
F206 WAS 3AMP C.O. #2536 FMA 8-29-44 E
ADD SUB TO TITLE CHANGE CABLE TO MATCH W-3F-W73 RX1149 WAS WX4831 R205 WAS 7500 Ω R202 WAS 3500 Ω R201 WAS 1500 Ω REMOVE V203 & V204 C.O. #9456 T.00 FMH 1-18-44 D
R213 WAS 50 Ω C.O. #9326 FMA 1-1-44 C
SEE RECORD PRINT SUB A B
MAT. SQ. NO. REF. PT. DESCRIPTION
DR. ... 11-7-42 APP. ... CHK.
CRP
REGT. POWER UNIT FOR SO-1 & SO-8 RADAR
FIRST USED ON RX 1149
RAYTHEON MFG. CO. WALTHAM. MASS.
SPEC. NO. GR.
W-4F--V1 SUB E

Model SO-1 — W-4F-V1 sub E Rectifier Power Unit (later type)


CONFIDENTIAL
PRODUCTION DRAWING
CHANGE PER
ENGINEERING CO. ONLY
Z301
RF301
V309
CAP
E303
RF302
Z302
OSCILLATOR CABLE
MIXER CABLE
RF303
Z303
P304
J304
2J26
OR 2J27
RF304
V311
E305
P308
P309
J305
C344 .5
R336
R337
R338
R342
R343
R344
R345
R346
1000
7X10000
C345
.025
C342
.02
C343
T302A
W-301
T302B
2 MEG
R334
200000
R335
200000
R341
C341
.001
T303
L320
L321
R339 10000 OHMS
707B
V310
C348
.001
6
7
2
3
.001
C349
.050
R340
.001
C350
P301
J301
J302
CRP-46ACA -1
P302
(P306)
J303
P303
RECEIVER POWER CABLE
BLACK
BRAID
WHITE
RED
BLUE
GREEN
17
31
32
33
34
35
E302
B301
E304
S301
S302
C347
.5
VIDEO
CABLE
16
17
18
19
20
21
23
24
25
30
31
J
32
33
34
35
P307
J307
TO CRP-20225
RECT. POWER UNIT
TO CRP-55 ADQ
P.P.I.
TO CRP-20226
RECT. POWER UNIT
E301
E
CRP-46ACA
-1 ADDED
"D" CHANGED
TC "J" Apr
CO 1192 1944
B
ADDED PARTS
VALUES REF
RELOCD POINT
CO 7832
C
REMOVED "SO-I MAR"
FROM TITLE-CHANGED
LEAD FROM TERM.
30 TO OTHER SIDE
OF L321-EXCHANGED
2&7 PIN DESIGNATIONS
ON V310
CO 9501
FCH 1-20-44
D
R339 10000
OHMS. WAS 1 MEG.
CO. 9950
DAT 3-7-44
E
DR.
DATE 1-29-43
APP.
CHK.
CRP-43ABY TRANSMITTER-RECEIVER
SCHEMATIC
FIRST USED ON WX4832
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4B-U2
SUB
E

Model SO-1 — W-4B-U2 sub E Transmitter-Receiver

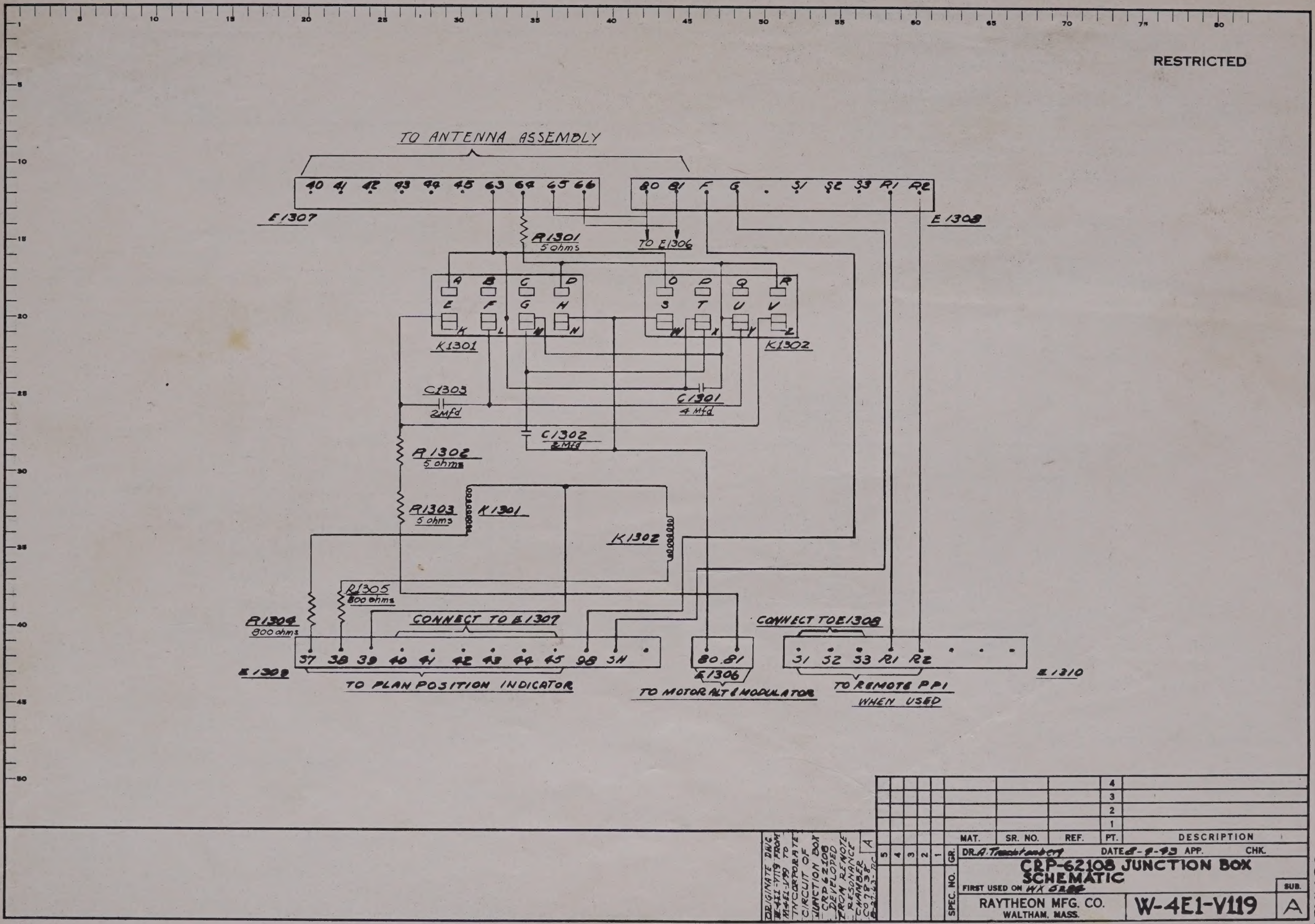

CONFIDENTIAL
PRINT DISTRIBUTION
A B C D E F G H J K L M
PRODUCTION DRAWING
CHANGES PER
ENGINEERING CO. ONLY
TO RECTIFIER POWER UNIT-
CRP-20225 FOR SO-1
CRP-20237 VIA P-307 FOR SO-2
GROUND ON PIN #1
J301
J302
P302
J303
.00001 C301
C302 .001
R301 100
L301
L302
L303
L304
L305
L306
L307
L308
L309
L322
V301
V302
V303
V304
V305
V306
V307
V308
R304 1000
R305 50
R306 50
R307 1000
R308 250
R309 50
R310 1000
R311 250
R312 50
R313 1000
R314 250
R315 50
R316 1000
R317 250
R318 75
R319 67000
R320 250
R321 250
R322 5,000
R323 25000
R324 100,000
R325 250,000
R328 250
R329
R330 250
R331 250
R332
R333
C303 .001
C304
C305 .001
C306
C307 .0001
C309 .001
C310 .0001
C311 .001
C312 .001
C313 .0001
C314 .001
C315 .001
C316 .0001
C317 .001
C318 .001
C319
C320 .001
C321 .001
C322 .001
C323 .0001
C324 .01
C325 .01
C326 .01
C327B 0.1
C327C 0.1
C328 .01
C329 .01
C330 .01
C331 .01
C332 .01
C333 .01
C334 .01
C335 .01
C336 .001
C337 .001
C338 .001
C339
C340
C351 .001
C352 .0001
C353 .001
1
2
3
4
5
6
7
8
17
32
33
34
35
(E 302)
L310
L311
L312
L313
L314
L315
L316
L317
L318
L319
T301
35 TURNS 1½ LAYERS #23 ENAMELED WIRE - L-310 - L319 INC.
NOTE: ALL TUBES ARE 1852/6AC7 TYPE
Variations on Finished Dimensions unless otherwise marked.
BASIC DIMENSIONS | FRACTIONAL DIMENSIONS | DECIMAL DIMENSIONS
UP TO ½ | ± 1/100 | ± .005
ABOVE ½ TO 6 | ± 1/64 | ± .005
ABOVE 6 TO 24 | ± 1/32 | ± .010
ABOVE 24 | ± 1/16 | ± .015
MOVED LEAD FROM R330 TO C327B & LEAD FROM R325 TO C352 & L322 CO 9630 RCH 2-8-44 G
ADDED VALUE .001 TO C353 REMOVED JUMPER FROM PINS OF V308 TO R325 — CHANGED LEAD FROM R325 TO JUNCTION OF L322 & C327B ADDED VALUE .0001 TO C352 REMOVED "SO-1 AND SO-2 RADARS" FROM TITLE L301 WAS 8 TURNS- L302 THRU L308 WAS 11 TURNS CO 9501 RCH 1-20-44 F
L301 WAS 9 TURNS L303 WAS 12, L304 WAS 12, L305 WAS 12 L306 WAS 12, L307 WAS 12 L308 WAS 12 CO 9093 12-9-43 E
ADD-C352-C353 L322-ADD PIN NO'S CO 7965 3-4-43 D
FOR CHANGES SEE RECORD PRT. SUB B CC# 7723 AWD E-14-43 C
MOVED L309 & C324 TO OPPOSITE SIDE OF C325- ADDED C351 C.O. 7674 RCH 8-11-43 B
5 4 3 2 1 GR.
MAT. SR. NO. REF. PT. DESCRIPTION
4 3 2 1
DR. Maynord Cred-9/6/42.
APP.
CHK.
SPEC. NO.
CRP-46ACA-1 RADAR RECEIVER STRIP
FIRST USED ON WX5229
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4B2-V5
SUB
G

COIL TABLE

SYMBOL	TURNS
L-301	9
L-302	12
L-303	12
L-304	12
L-305	12
L-306	12
L-307	12
L-308	12

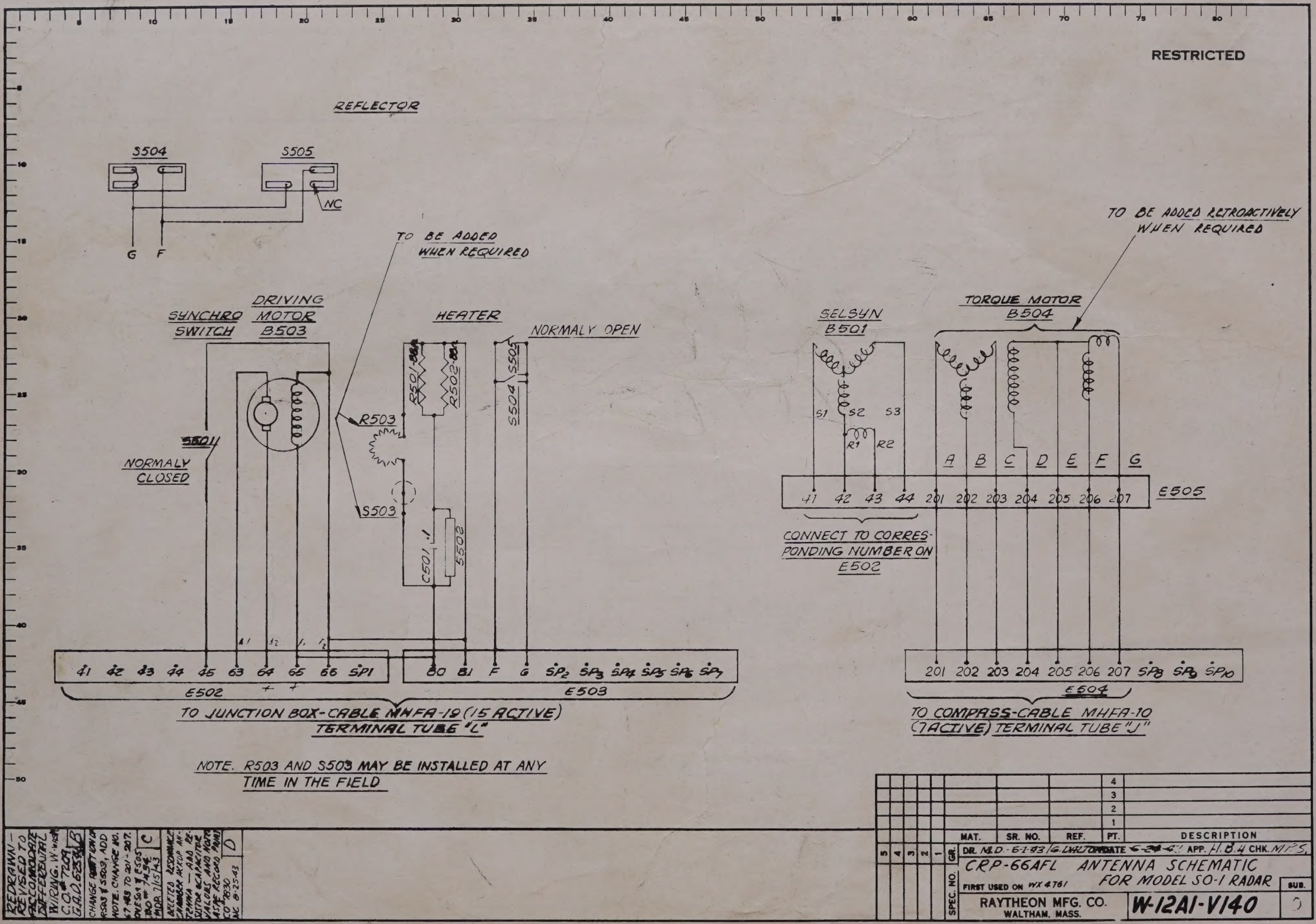
L-309 —— 150 μhy.
L-322 —— 150 μhy.

Model SO-1 — W-4B2-V5 sub G Receiver


RESTRICTED
TO ANTENNA ASSEMBLY
40 41 42 43 44 45 63 64 65 66
E1307
80 81 F G . 31 32 33 R1 R2
E1308
R1301
5 ohms
TO E1306
A B C D
E F G H
K L M N
K1301
O P Q R
S T U V
W X Y Z
K1302
C1303
2 Mfd
C1301
4 Mfd
C1302
2 Mfd
R1302
5 ohms
R1303
5 ohms
K1301
K1302
R1305
800 ohms
R1304
800 ohms
CONNECT TO E1307
CONNECT TO E1308
37 38 39 40 41 42 43 44 45 98 34
E1309
TO PLAN POSITION INDICATOR
80 81
E1306
TO MOTOR ALT & MODULATOR
31 32 33 R1 R2
E1310
TO REMOTE PPI WHEN USED
ORIGINATE DWG W-4E1-V119 FROM M-4E1-V99 TO INCORPORATE CIRCUIT OF JUNCTION BOX CRP-62108 DEVELOPED FROM REMOTE RESONANCE CHAMBER CO7838 8-27-43-RC
A
5 4 3 2 1 GR.
SPEC. NO.
MAT. SR. NO. REF. PT. DESCRIPTION
4 3 2 1
DR. A. Trachtenberg DATE 8-9-43 APP. CHK.
CRP-62108 JUNCTION BOX SCHEMATIC
FIRST USED ON WX 6288
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-4E1-V119
SUB.
A

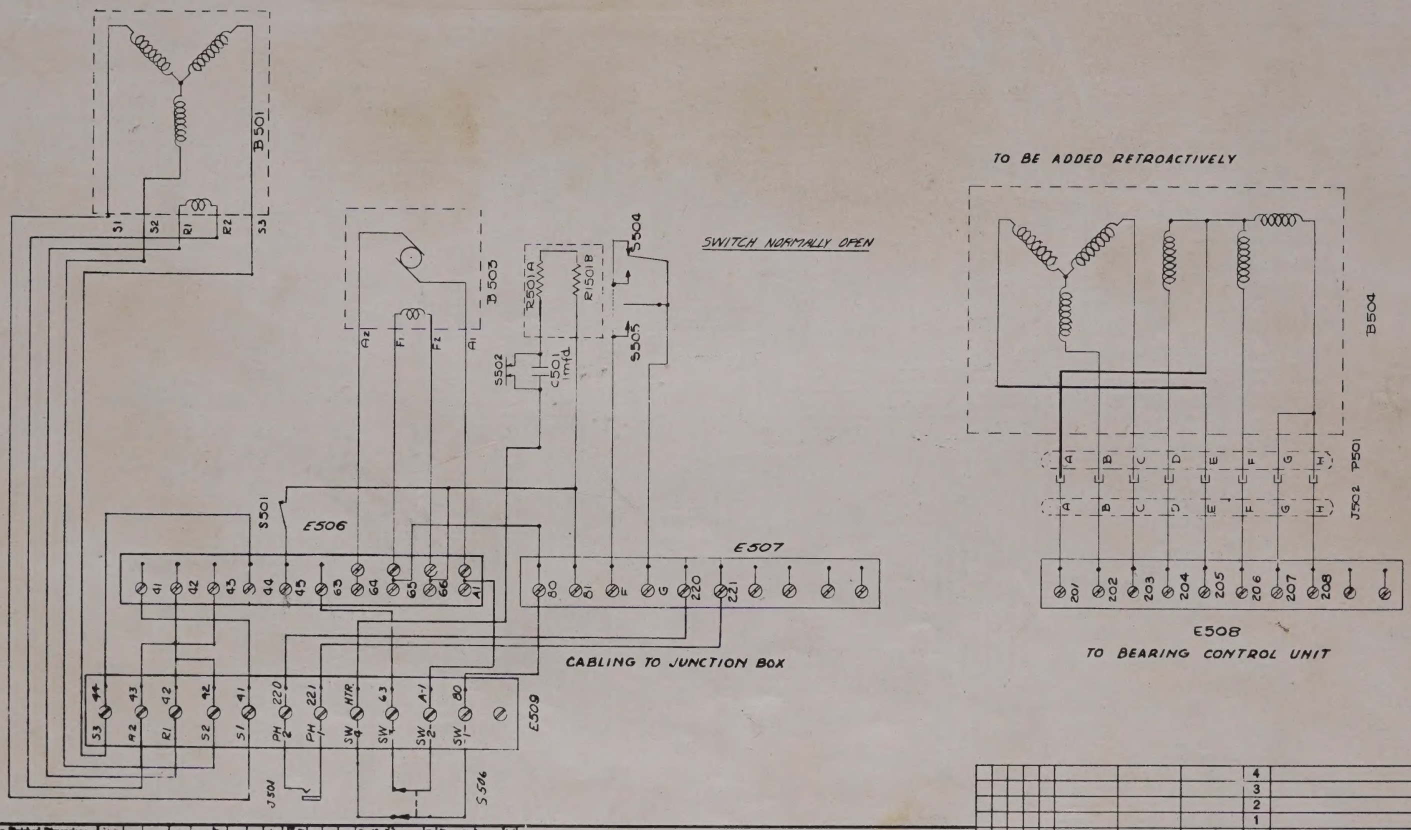
Model SO-1 — W-4E1-V119 sub A Junction Box

CONFIDENTIAL


RESTRICTED
REFLECTOR
S504
S505
NC
G
F
TO BE ADDED WHEN REQUIRED
TO BE ADDED RETROACTIVELY WHEN REQUIRED
SYNCHRO SWITCH
DRIVING MOTOR B503
HEATER
NORMALY OPEN
S501
NORMALY CLOSED
R503
S503
R501-38
R502-38
S505
S504
C501 .1
S502
SELSYN B501
S1
S2
S3
R1
R2
TORQUE MOTOR B504
A
B
C
D
E
F
G
41 42 43 44 201 202 203 204 205 206 207
E505
CONNECT TO CORRESPONDING NUMBER ON E502
41 42 43 44 45 63 64 65 66 SP1
E502
80 81 F G SP2 SP3 SP4 SP5 SP6 SP7
E503
TO JUNCTION BOX-CABLE MHFA-19 (15 ACTIVE) TERMINAL TUBE "L"
201 202 203 204 205 206 207 SP8 SP9 SP10
E504
TO COMPASS-CABLE MHFA-10 (7ACTIVE) TERMINAL TUBE "J"
NOTE. R503 AND S503 MAY BE INSTALLED AT ANY TIME IN THE FIELD
REDRAWN — REVISED TO ACCOMMODATE DIFFERENTIAL WIRING. W-WASH C.O. # 7209 G.A.D. 6-25-43
B
CHANGE POSITION OF R503 & S503, ADD NOTE. CHANGE NO. 57 43 TO 201-207. ON E504 & E505 AO # 7434 MDR 7/15/43
C
DELETED RESONANCE CHAMBER PICKUP ANTENNA — ADD RESISTOR & CAPACITOR VALUES AND NOTE AS PER RECORD PRINT CO 7830 WC 8-25-43
D
4
3
2
1
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
5
4
3
2
1
GR.
SPEC. NO.
DR. M.D. 6-1-43
G. LHLTON
DATE 6-24-43
APP. H.B.4
CHK. M.P.S.
CRP-66AFL ANTENNA SCHEMATIC FOR MODEL SO-1 RADAR
FIRST USED ON WX 4761
RAYTHEON MFG. CO. WALTHAM, MASS.
W-12A1-V140
SUB.
D

Model SO-1 — W-12A1-V140 sub D Antenna CRP-66AFL

CONFIDENTIAL


B501
S1
S2
R1
R2
S3
B503
A2
F1
F2
A1
R501A
R1501B
C501
1mfd
S502
S504
S505
SWITCH NORMALLY OPEN
S501
E506
41
42
43
44
45
63
64
65
66
A1
E507
80
81
F
G
220
221
CABLING TO JUNCTION BOX
E509
S3
44
R2
43
R1
42
S2
42
S1
41
PH 2
220
PH 1
221
SW 4
HTR
SW 3
63
SW 2
A-1
SW 1
80
J501
S506
TO BE ADDED RETROACTIVELY
B504
A
B
C
D
E
F
G
H
P501
J502
201
202
203
204
205
206
207
208
E508
TO BEARING CONTROL UNIT

Variations on Finished Dimensions unless otherwise marked.

Basic dimensions	Fractional dimensions	Decimal dimensions
Up to 6	± [illegible]	± .005
Above 6 to [illegible]	± [illegible]	± .005
Above [illegible] to 24	± [illegible]	± .010
Above 24	± [illegible]	± .015

CHANGES PER RECORD PRINT 11-8-43 G.H. B

CHANGE PER RECORD PRINT 11/12/43 D.P. CO 10800 C

ADD-J501-S506 CO. 10213 11-17-43 D

GENL. WIRING CHG. & J502 WAS J501 C.O. 1035 E

PHONE JACK WAS J502 AMPH PLUG WAS J501 CO N361 F

220 WAS 221 & 221 WAS 220 MLNE CO 10371 G

E506 WAS E503; E507 WAS E502; E508 WAS E501; E201 WAS E199; E208 WAS E206 ADDED E509 CO# 10574 2-1-44 EMC H

202 WAS 200; 203 WAS 201; 204 WAS 202; 205 WAS 203; 206 WAS 204; 207 WAS 205 G.O. 10605 2-5-44 RMC I

5	4	3	2	1	MAT.	SR. NO.	REF.	PT.	DESCRIPTION
								1	
								2	
								3	
								4	

SPEC. NO. GR.

DR. 11-4-43 APP. CHK.

CRP-66AGE - SO-1 ANTENNA-SCHEMATIC

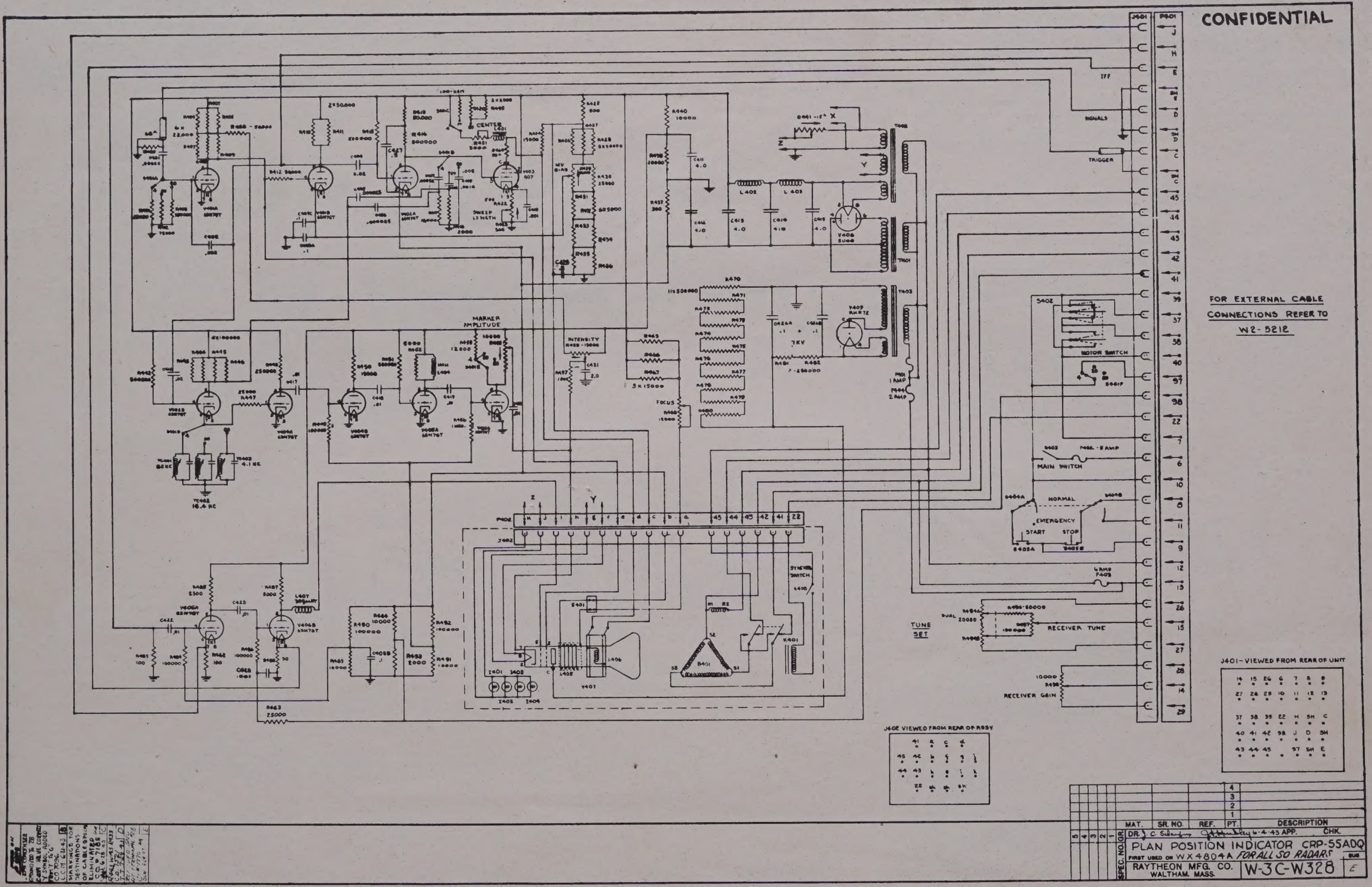
FIRST USED ON WX4763

RAYTHEON MFG. CO.
WALTHAM, MASS.

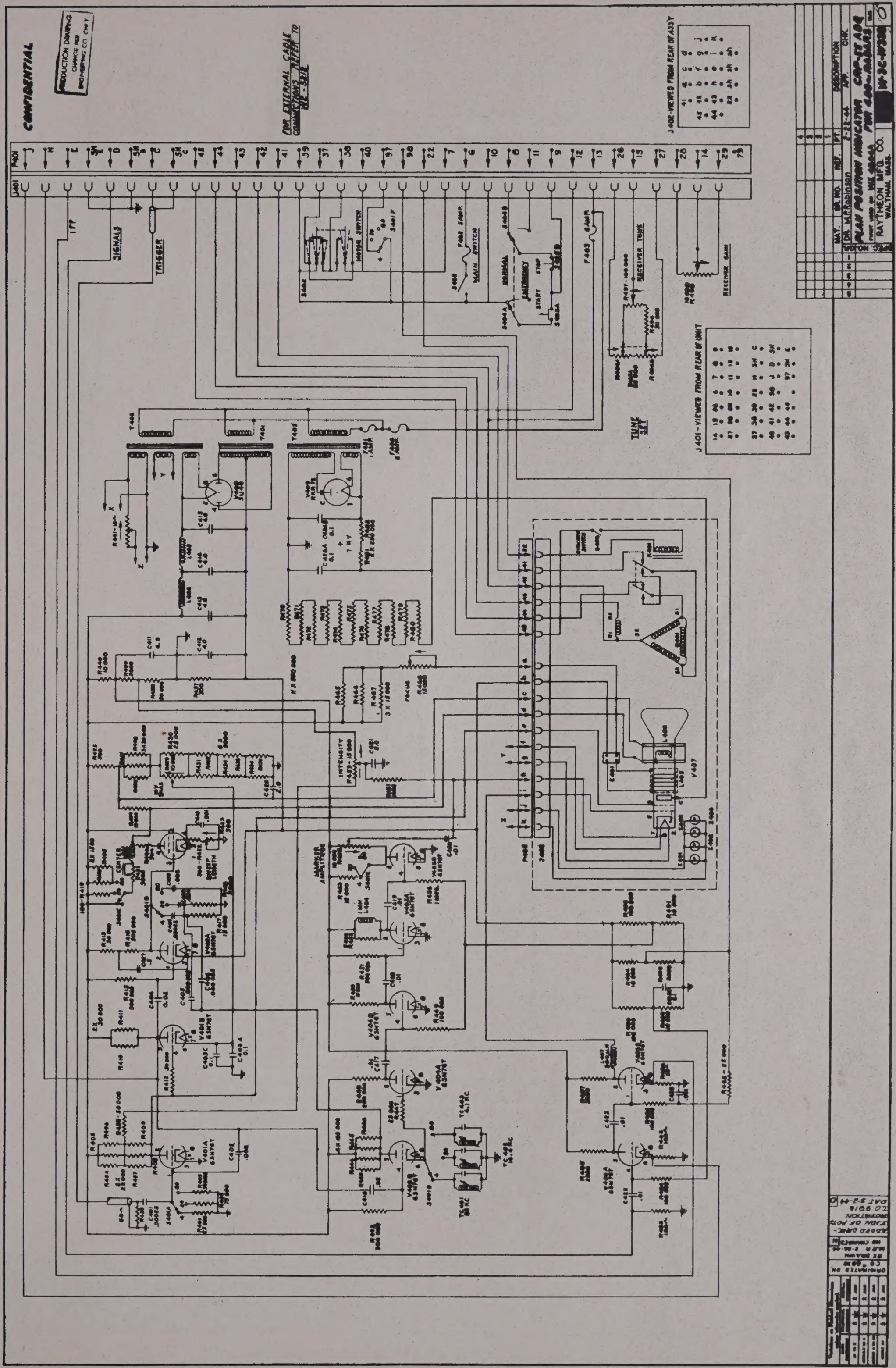
[redacted] W-14A1V296 SUB I

Model SO-1 — W-14A1-V296 sub I Antenna CRP-66AGE

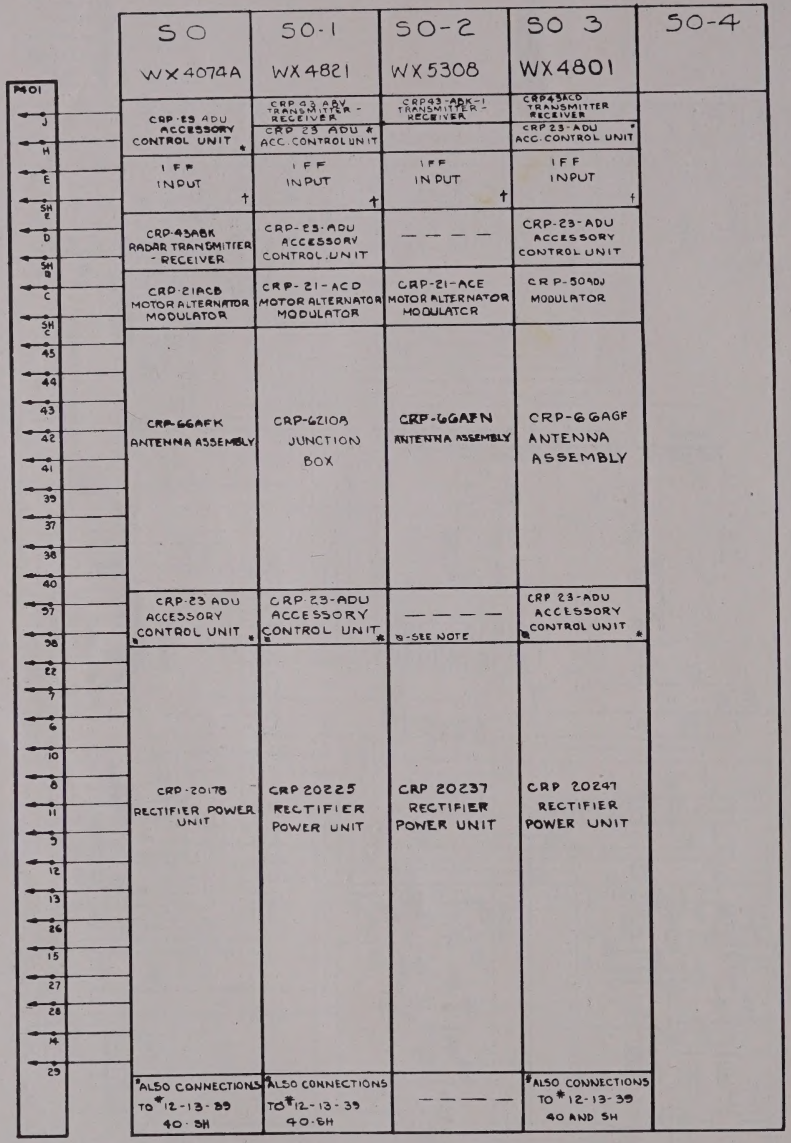
CONFIDENTIAL


CONFIDENTIAL
FOR EXTERNAL CABLE CONNECTIONS REFER TO W2-5212
J401
P401
IFF
SIGNALS
TRIGGER
CENTER
SWEEP LENGTH
MARKER AMPLITUDE
INTENSITY
FOCUS
L402
L403
V408
V409
T401
T402
T403
MOTOR SWITCH
S402
MAIN SWITCH
NORMAL
EMERGENCY
START
STOP
RECEIVER TUNE
TUNE SET
RECEIVER GAIN
SYNCHRO SWITCH
K401
B401
V401
P402
J402
J401 - VIEWED FROM REAR OF UNIT
J402 VIEWED FROM REAR OF ASSY
MAT.
SR. NO.
REF.
PT.
DESCRIPTION
DR. J. C. Schaefer
6-4-43 APP.
CHK.
SPEC. NO.
GR.
PLAN POSITION INDICATOR CRP-55ADQ
FIRST USED ON WX4804A FOR ALL SO RADARS
RAYTHEON MFG. CO. WALTHAM, MASS.
W-3C-W328
SUB
E

Model SO-1 — W-3C-W328 sub E Plan Position Indicator (early type)


CONFIDENTIAL
PRODUCTION DRAWING CHANGE PER ENGINEERING CO. ONLY
FOR EXTERNAL CABLE CONNECTIONS REFER TO
IFF
SIGNALS
TRIGGER
MOTOR SWITCH
MAIN SWITCH
RECEIVER TUNE
RECEIVER GAIN
J402 - VIEWED FROM REAR OF ASS'Y
J401 - VIEWED FROM REAR OF UNIT
TUNE SET
INTENSITY
FOCUS
V407
PLAN POSITION INDICATOR
RAYTHEON MFG. CO.
WALTHAM, MASS.
W-3C-W328

Model SO-1 — W-3C-W328 sub O Plan Position Indicator (later type)



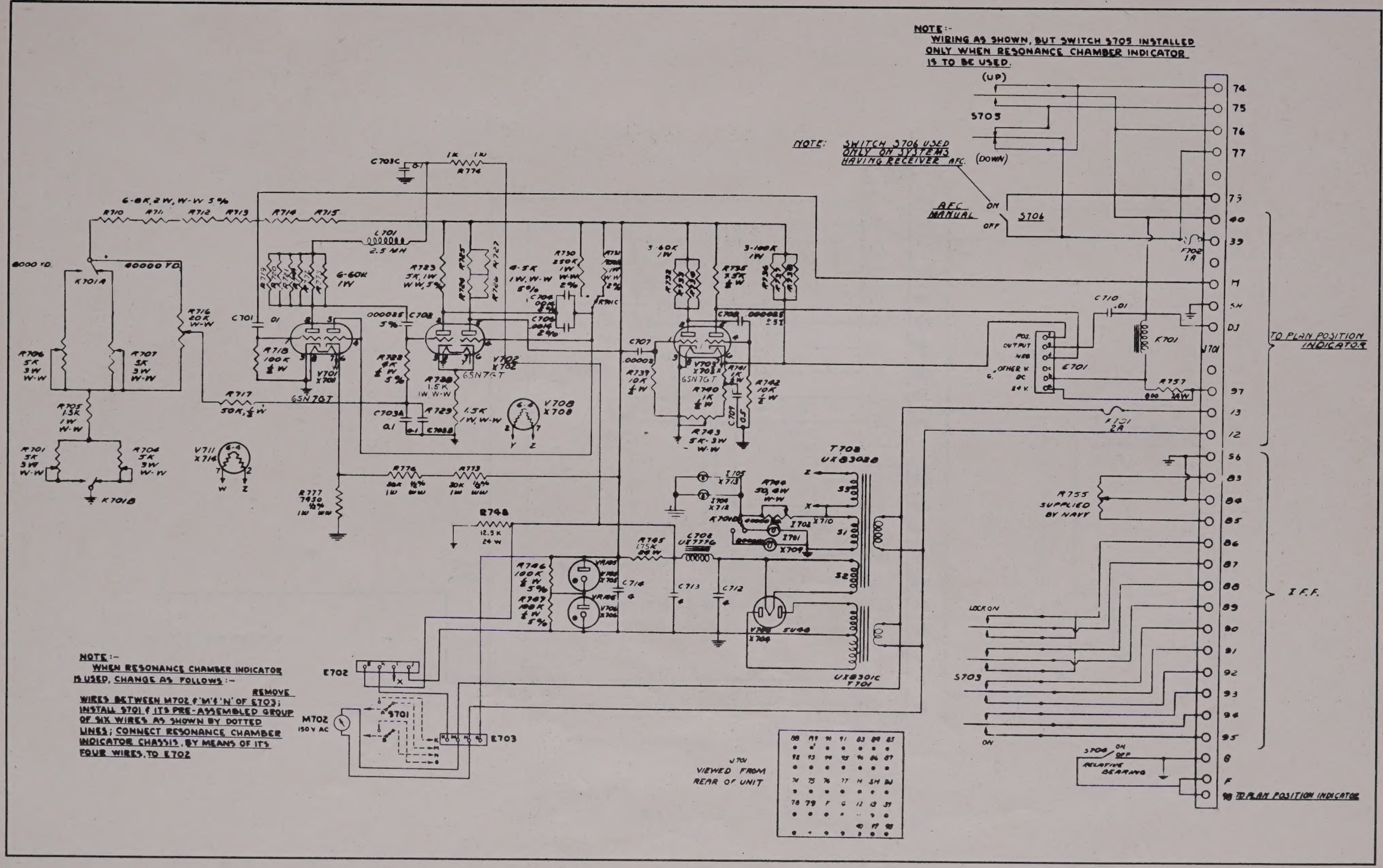
FOR USE WITH
SCHEMATIC
W-3C-W328

P401	SO WX4074A	SO-1 WX4821	SO-2 WX5308	SO 3 WX4801	SO-4
J H	CRP-23 ADU ACCESSORY CONTROL UNIT *	CRP 43 ABV TRANSMITTER - RECEIVER CRP 23 ADU * ACC. CONTROL UNIT	CRP43-ABK-1 TRANSMITTER - RECEIVER	CRP43ACD TRANSMITTER RECEIVER CRP 23-ADU * ACC. CONTROL UNIT	
E SH E	IFF INPUT †	IFF INPUT †	IFF IN PUT †	IFF INPUT †	
D SH D	CRP-43ABK RADAR TRANSMITTER - RECEIVER	CRP-23-ADU ACCESSORY CONTROL UNIT	— — — —	CRP-23-ADU ACCESSORY CONTROL UNIT	
C SH C	CRP-21ACB MOTOR ALTERNATOR MODULATOR	CRP-21-ACD MOTOR ALTERNATOR MODULATOR	CRP-21-ACE MOTOR ALTERNATOR MODULATCR	CRP-50ADJ MODULATOR	
45 44 43 42 41 39 37 38 40	CRP-66AFK ANTENNA ASSEMBLY	CRP-6210B JUNCTION BOX	CRP-66AFN ANTENNA ASSEMBLY	CRP-66AGF ANTENNA ASSEMBLY	
97 98	CRP-23 ADU ACCESSORY CONTROL UNIT *	CRP-23-ADU ACCESSORY CONTROL UNIT *	— — — — -SEE NOTE	CRP 23-ADU ACCESSORY CONTROL UNIT *	
22 7 6 10 8 11 9 12 13 26 15 27 28 14 29	CRP-20178 RECTIFIER POWER UNIT	CRP 20225 RECTIFIER POWER UNIT	CRP 20237 RECTIFIER POWER UNIT	CRP 20247 RECTIFIER POWER UNIT	
	*ALSO CONNECTIONS TO #12-13-39 40-SH	*ALSO CONNECTIONS TO #12-13-39 40-SH	— — — —	*ALSO CONNECTIONS TO #12-13-39 40 AND SH	

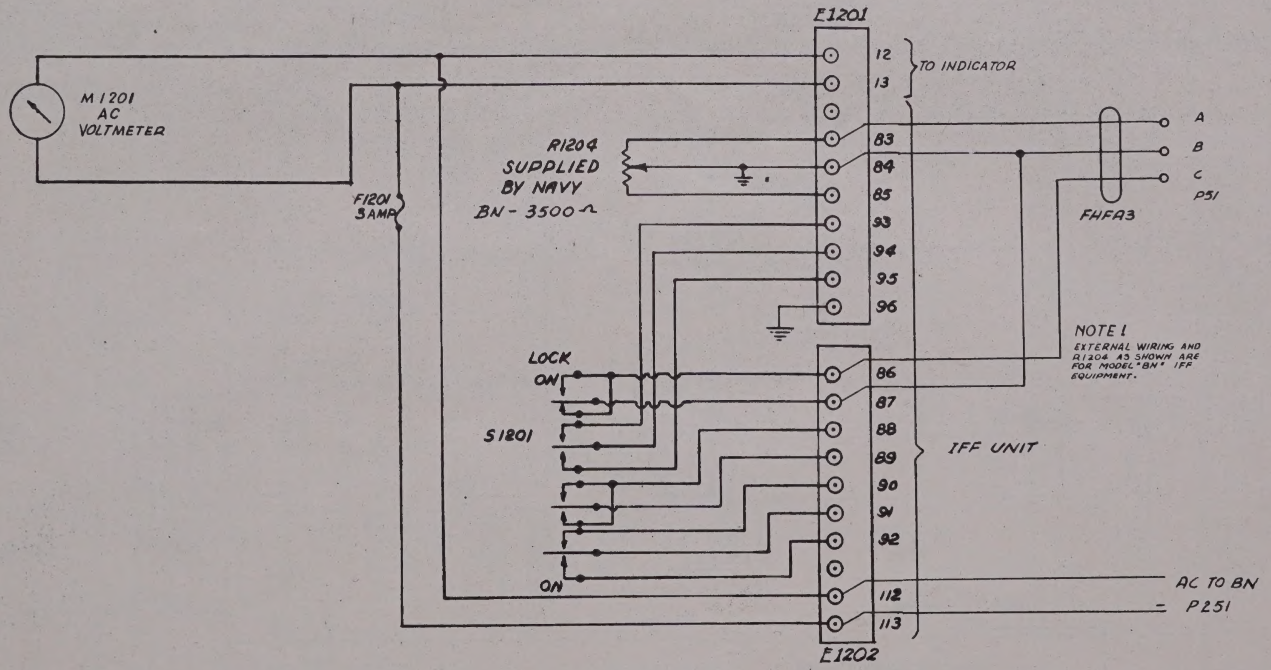
† 115V 400 ∿ SUPPLY FOR I.F.F. EQUIPMENT MAY BE TAKEN OFF AT #12 AND #13 UNLESS ACCESSORY CONTROL UNIT IS USED. [I.F.F. CONTROL UNIT IS CRP-23ADD.] IF ACCESSORY CONTROL UNIT IS USED IN CONJUNCTION WITH THE INDICATOR THE I.F.F. SUPPLY MAY BE FROM #12 AND #13 OF THE ACCESSORY CONTROL UNIT.

NOTE - IF ACCESSORY CONTROL UNIT IS NOT USED, A JUMPER SHOULD BE CONNECTED BETWEEN #98 AND "SH.D" OR "SH.E" WHEN MAKING INSTALLATION.

DR. J. A. Hubley	DATE 6-28-43	APP. SKG	CHK.
EXTERNAL CABLE CONNECTIONS CRP55ADQ			
FIRST USED ON WX4804			SUB
RAYTHEON MFG. CO. WALTHAM, MASS.	W2-5212		3


NOTE:-
WIRING AS SHOWN, BUT SWITCH S705 INSTALLED ONLY WHEN RESONANCE CHAMBER INDICATOR IS TO BE USED.
(UP)
S705
(DOWN)
NOTE: SWITCH S706 USED ONLY ON SYSTEMS HAVING RECEIVER AFC.
AFC
MANUAL
ON
OFF
S706
F702 1A
74
75
76
77
73
40
39
H
SH
DJ
J701
97
13
12
56
83
84
85
86
87
88
89
90
91
92
93
94
95
G
F
98
TO PLAN POSITION INDICATOR
I.F.F.
LOCK ON
S703
ON
R755 SUPPLIED BY NAVY
S708 ON OFF
RELATIVE BEARING
TO PLAN POSITION INDICATOR
K701
C710 .01
R757
F701 2A
E701
POS. OUTPUT
NEG.
OTHER K
DC
24 V.
T708 UX8302B
T701 UX8301C
L702 UX7776
V709 X709
V704 5U4G X704
C712
C713
C714
R745 17.5K
R746 100K
R747 100K
R748 12.5K 24 W
V705 X705
V706 X706
E702
E703
M702 150 V AC
S701
NOTE:-
WHEN RESONANCE CHAMBER INDICATOR IS USED, CHANGE AS FOLLOWS:-
REMOVE WIRES BETWEEN M702 & 'M' & 'N' OF E703; INSTALL S701 & ITS PRE-ASSEMBLED GROUP OF SIX WIRES AS SHOWN BY DOTTED LINES; CONNECT RESONANCE CHAMBER INDICATOR CHASSIS, BY MEANS OF ITS FOUR WIRES, TO E702
J701 VIEWED FROM REAR OF UNIT
88 89 90 91 83 84 85
92 93 94 95 96 86 87
74 75 76 77 H SH DJ
78 79 F G 12 13 39
40 97 98
V701 X701 6SN7GT
V702 X702 6SN7GT
V703 X703 6SN7GT
V708 X708
V711 X714
C701 .01
C703C .01
C703A 0.1
C707 .00002
C708 .000025
L701 2.5 MH
R710
R711
R712
R713
R714
R715
6-8K, 2W, W-W 5%
8000 YD.
80000 YD.
K701A
K701B
R706 5K 3W W-W
R707 5K 3W W-W
R705 1.5K 1W W-W
R701 5K 3W W-W
R704 5K 3W W-W
R716 20K W-W
R717 50K, ½W
R718 100K ½W
6-60K 1W
R723 5K, 1W WW, 5%
R728 8K ½W 5%
R738 1.5K 1W W-W
R729 1.5K 1W, W-W
R730 250K 1W W-W 2%
R731
R737 10K ½W
R740 1K ½W
R741 1K ½W
R742 10K ½W
R743 5K-3W W-W
R744 50, 6W W-W
3-60K 1W
3-100K 1W
R735 3.5K ½W
R773 30K ½% 1W WW
R774 80K ½% 1W WW
R775 1K 1W
R776
R777 7430 ½% 1W WW
I705 X713
I706 X712
I701
I702 X710
K701C

Model SO-1 — W-3K22-W204 sub J Accessory Control Unit


E1201
12
13
TO INDICATOR
83
84
85
93
94
95
96
M1201
AC
VOLTMETER
R1204
SUPPLIED
BY NAVY
BN - 3500 Ω
F1201
3AMP
A
B
C
P51
FHFA3
NOTE I
EXTERNAL WIRING AND R1204 AS SHOWN ARE FOR MODEL "BN" IFF EQUIPMENT.
LOCK
ON
S1201
ON
86
87
88
89
90
91
92
112
113
IFF UNIT
AC TO BN
P251
E1202

Model SO-1 — W-30A1-U5 sub E IFF Control Unit and Line Voltmeter

PARTS LIST

FOR

NAVY MODEL SO-1
RADAR EQUIPMENT

CONFIDENTIAL

TABLE I
LIST OF MAJOR UNITS FOR MODEL SO-1 RADAR EQUIPMENT
WX-4821A

Equipment Spares	WX-3392
Tender Spares	WX-3393
Stock Spares	WX-5643

Navy Type Designation	Name of Major Unit (Model SO-1 Radar Equipment)	Table II		Assembly Drawing Number
		Symbol Group	Page Numbers	
	Motor-Alternator and Modulator Assy.	101 to 199	1 to 1-h	
*CLL-211043	Motor-Alternator and Mounting Base			A4D16-W134
CRP-10249	Spark Gap			A33B10-X60
CRP-50ACX	Modulator			A-4D1-X2
CRP-20286	Rectifier Power Unit	201 to 299	2 to 2-b	
CRP-43ABY	Radar Transmitter-Receiver	301 to 399	3 to 3-h	A-3B-X1
CRP-46ACA-1	Radar Receiver			A-4B2-X4
CRP-55ADQ	Plan Position Indicator	401 to 499	4 to 4-j	A-3C17-X191
CRP-66AGE	Antenna Assembly	501 to 599	5 to 5-c	A-14A1-X1
CRP-14AAN	Resonance Chamber	601 to 699	6	A-3E-W1
CRP-62108	Junction Box	1301 to 1399	13 to 13-a	A-4E1-U100
CDD-211045	Magnetic Controller	101 to 199	25	91-5084
CBZ-24216	Stop-Start Switch		25	28-5091P2
	Miscellaneous Tools, Wire, Parts and Hdwe.		26 to 26-b	
	ACCESSORIES			
CRP-23ADZ	Accessory Control Unit	701 to 799		
CRP-10252	Mounting Rack			
CRP-23AEK	Bearing Control Unit	1401 to 1499		
CRP-23ADD	IFF Control Unit	1201 to 1299	12	A-30A1-W1

* Alternate Motor-Alternator & Mounting Base is CNH-211043-A

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MOTOR-ALTERNATOR AND MODULATOR													
		Motor-alternator and modulator assy.			28	WX-5276A	4D-1	101		0		0		1	
		Motor-alternator and mounting base.	-211043		28	WX-5125	4D16-134	102		0		0		1	
		Spark gap.	-10249		28	WX-5666	33B10-60	103	1	1		2		3	
		Modulator	-50ACX		28	WX-5301	4D1-2			0		0		0	
		MOTORS AND SYNCHRO UNITS													
B105		Drive motor, 115 v dc, 4HP, 3450 rpm.			37	SD-88	115-5074			0		0		0	B105
B105A		Rotor assembly with bearings.			37		115-5075	110		0		1		2	B105A
B105B		Set (4) brushes.			37	A-4762	103-5064	111	1	5		10		20	B105B
B105C		Brush holder with spring.			37	SA-4409	103-5065	112	1	1		4		6	B105C
B105D		Set (4) brush tension springs.			37	A-3938	88-5062	113	1	2		3		9	B105D, G101E
B105E		Brush holder insulating ring.			37	A-3902	103-5059	114	1	1		2		3	B105E, G101F
B105F		Stator assembly including field coils.			37		115-5076	115		0		2		4	B105F
B105-1		Motor 115 v dc, 3HP.			89		115-5077			0		0		0	
B105-1A		Rotor assembly with bearings.			89		115-5078	117		0		1		2	B105-1A
B105-1B		Set (4) brushes.			89		103-5068	118	1	5		10		20	B105-1B
B105-1C		Set (4) brush holder assemblies with springs.			89		103-5069	119	1	1		4		6	B105-1C
B105-1D		Set (4) brush tension springs.			89		88-5065	120	1	2		3		9	B105-1D
B105-1E		Brush holder insulating ring.			89		36-5106	121	1	1		2		3	B105-1E
B105-1F		Set (4) field coils.			89		115-5079	122		0		2		4	B105-1F
B105-1G		Set (4) field interpole coils.			89		115-5080	123		0		2		4	B105-1G
B106	V101 bias battery	Battery, 22½ v.	-19033		86		11D1-47G1	124		0		4		0	B106
		CAPACITORS													
C101	V101 plate by-pass capacitor	Capacitor, paper, .01 mfd., +20%-10%, 600 v dc wkg.		RE 13A 488D	33	PX24A	35-5089	129	1	1		2		3	C101
C102	V102 cathode by-pass capacitor	Capacitor, paper, 1.0 mfd., ±10%, 600 v dc wkg.	-48600-A10		33	2528-11	35-5101	130	1	1		2		3	C102
C103	G101 regulator field by-pass cap.	Capacitor, paper, 4 mfd., ±10%, 600 v dc wkg.		RE 48A 488A	33	2538-3	35-5094	131	1	1		2		3	C103

0 No spares furnished

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		CAPACITORS (Cont'd)													
C104	S107 contact by-pass capacitor	Capacitor, paper, .25 mfd., ±10%, 600 v dc wkg.	-48288-A10		33	2528-5	35-5121	132	1	1		2		3	C104
C106	V103 by-pass capacitor	Capacitor, paper, .0001 mfd,, ±10%, 500 v dc wkg.	-48674-10		32	MOW-1416	35-5021	133	1	1		2		3	C106
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E102	Charging trans. terminal strip	Terminal strip, bakelite barrier type, 5 solder terminals with 6-32 x ¼" binder head screws.			21	5-141-¾W	47-5045P3	138		0		0		1	E102, E114
E110	B106 terminal strip	Terminal strip, bakelite barrier type, 2 solder terminals with 5-40 x 3/16" binder head screws.			21	2-140-¾W	47-5047P3	139		0		0		1	E110
E111	Alternator terminal strip	Terminal strip, bakelite barrier type, 8 solder terminals with 8-32 x 5/16" binder head screws.			21	8-142-¾W	47-5022P3	140		0		0		1	E111
E112	Control circuit terminal strip	Terminal strip, bakelite barrier type, 7 solder terminals with 8-32 x 5/16" binder head screws.			21	7-142-¾W	47-5061P3	141		0		0		1	E112
E113	Output terminal strip	Terminal strip, bakelite barrier type, 9 solder terminals with 8-32 x 5/16" binder head screws.			21	9-142-¾W	47-5055P3	142		0		0		1	E113
E114	VR-102 terminal strip	Same as E102								-		-		-	
E117	Control circuit, terminal strip at S108	Terminal strip, bakelite barrier type, 4 terminals with 6-32 screws.			1	X38045	47-5059	144		0		0		1	E117
		Insulator, ceramic ½" square, 1½" long, tapped 6-32, 3/8" deep at each end.			40	1650	22-5052	146	1	1		1		2	
		Insulator, ceramic, 1½" long, ¾" dia. tapped 10-32, ½" deep at each end.			40	1012	22-5018	147	1	1		1		2	
		Insulator, ceramic, 1¼" long, ½" dia. tapped 8-32, ½" deep at each end.					22-5042P1	148	1	1		1		2	
		Insulator, ceramic 1" square, 1¼" long, tapped 8-32, 3/8" deep at each end.			40	1061	22-5049P1	149	1	1		1		2	
		FUSES													
F104	Regulator power supply fuse	Fuse, 1 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25001	26-5035	152	1	20		40		100	F104
F105	Starter holding circuit fuse	Fuse, 3 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25003	26-5037	153	1	10		20		50	F105

0 No spares furnished
- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		FUSES (Cont'd)													
F106	Antenna heater fuse	Fuse, 15 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25015	26-5044	154	1	10		20		50	F106
		GENERATORS													
G101		Alternator			37	SC-2335	115-5073			0		0		0	G101
G101A		Stator assembly for alternator.			37	SC-2250	115-5067	160		0		1		2	G101A
G101B		Alternator rotor complete with bearings.			37	SB-1412	115-5068	161		0		1		2	G101B
G101C		Set (4) brushes for alternator.			37	A3928	103-5058	162	1	5		10		20	G101C
G101D		Brush holder and spring for alternator.			37	SA4459	103-5057	163	1	1		2		3	G101D
G101E		Set (4) brush holder springs. Same as B105D.								-		-		-	
G101F		Set (2) brush holder insulators. Same as B105E.								-		-		-	
G101G		Set (2) brush & spring assemblies for exciter.			37	A681	103-5060	166	1	5		10		20	G101G
G101H		Set (2) brush holders for exciter.			37	2177-3	103-5061	167	1	1		4		6	G101H
G101J		Set (2 each of 2) brush holder insulators for exciter.			37	2008 2417-1	103-5062	168	1	1		2		3	G101J
G101K		Set (2) caps for brush holders.			37	420-1	4D-199	169	1	1		4		6	G101K
G101L		Set (2) field coils for exciter.			89		115-5070P2	170		0		2		4	G101L
G101M		Exciter rotor.			89		115-5069P2	171		0		1		2	G101M
		RECEPTACLES													
J105	IFF cable jack	Receptacle for single conductor plug.			28		6-5151G2"	176	1	1		1		2	J105, J106
J106	Trigger cable jack	Same as J105								-		-		-	
		CONTACTORS AND RELAYS													
K110	V103 plate relay	Relay, thermal time delay 100/130 v, dc single circuit, norm. open, contacts rated 2 a, timing 25 to 65 sec. at -30° to +50°C.			64	B-1501	71-5016	182	1	1		2		3	K110
K111	Starting relay	Relay 3PDT, contacts rated 15 amps dc, coil 6.0 v dc .422 amps.			75	BO9D-29	71-5026	183	1	1		2		3	K111

0 No spares furnished
- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		INDUCTORS AND CHOKES													
L101	Damping choke	Inductor, RF damping, 450-500 mh, 8000 v peak.			31	12670	92-5087	188	1	1		1		1	L101
		PLUGS AND PROBES													
P105	IFF cable plug	Connector, single shielded conductor.	-49268		28		6-5174G1	193	1	1		1		2	P105,P106
P105A		Gasket for plug					105-5650	194	1	1		2		4	P105A,P106A
P106	Trigger cable plug	Same as P105	-49268							-		-		-	
P106A		Same as P105A								-		-		-	
		RESISTORS													
R101	Modulator damping resistor	Resistor, wirewound, 160 Ω ±5%, Style B, Grade 1, Class II.	-63902E	RE 13A 372J Style B	27	Type B	80-5247	201	1	1		2		3	R101,R102,R103
R102	Modulator damping resistor	Same as R101	-63902E							-		-		-	
R103	Modulator damping resistor	Same as R101	-63902E							-		-		-	
R104	Voltage divider for trigger	Resistor, wirewound 25 Ω ±5%, Style F, Grade 2, Class I.	-63349-D	RE 13A 372J Style F	27	Type F	80-5246	204	1	1		2		3	R104
R105	Voltage divider for IFF	Resistor, wirewound 2.0 Ω ±10%, 1 watt.	-63288	RE 13A 372J	20	BW-1	80-5258	205	1	1		2		3	R105
R112	G101 regulator field damping resistor	Resistor, wirewound 50 Ω ±5%, Style D, Grade 2, Class I.	-63053D				80-5372	206	1	1		2		3	R112
R113	G101 field current control	Resistor, dual potentiometer, wirewound each section 250 Ω ±10%, 50 watts, linear taper, special shaft.			8	DPW50-250	40-5059P1	207	1	1		3		5	R113
R114	B105 field current control	Resistor, potentiometer, wirewound, 25 Ω ±10%, 50 watts, linear taper, special shaft.			8	PW50W	40-5044	208	1	1		3		5	R114
R116	V102 cathode resistor	Resistor, composition, 15,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5222	210	1	1		2		3	R116
R117	V101 bias control	Resistor, potentiometer, wirewound, 10,000 Ω ±10%, 4 watts, linear taper, special shaft.			8	P10W	40-5041	211	1	1		3		5	R117
R118	V102 cathode resistor	Resistor, composition, 10,000 Ω ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5271	212	1	1		2		3	R118
R119	V103 bias resistor	Resistor, composition, 150,000 Ω ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5280	213	1	1		2		3	R119
R120	S107 by-pass resistor	Resistor, wirewound, 100 Ω ±5%, Style B, Grade 2, Class I.	-63865-D		20		80-5379	214	1	1		2		3	R120
R121	K111 by-pass resistor	Resistor, wirewound, 10 Ω ±5%, Style F, Grade 2, Class I.	-631003-D		20		80-5373	215	1	1		2		3	R121

Revised 3-21-44

- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R122	B105 armature startup resistor	Resistor, steel grid, material specification 17R4 for #1 DC starter (10 per set).			42		4J-29	216	1	1		3		5	R122
R123	V102 cathode resistor	Resistor, composition, 7500Ω ± 10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5341	217	1	1		2		3	R123
R124	Limiting resistor	Resistor, composition, 50,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5231	218	1	1		2		3	R124
R125	G101 regulator field damping resistor	Resistor, potentiometer, wirewound, 225 Ω ±10%, 50 watts, linear taper, special shaft.			27	#0322	40-5055	219	1	1		3		5	R125
R140	Voltage divider resistor	Resistor, composition, 1 MΩ ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5338	220	1	1		2		3	R140, R141, R142, R143, R144, R145, R146, R147, R148, R149, R150, R151, R152, R153, R154, R155, R156, R157, R158, R159
R141	Voltage divider resistor	Same as R140	-63288							-		-		-	
R142	Voltage divider resistor	Same as R140	-63288							-		-		-	
R143	Voltage divider resistor	Same as R140	-63288							-		-		-	
R144	Voltage divider resistor	Same as R140	-63288							-		-		-	
R145	Voltage divider resistor	Same as R140	-63288							-		-		-	
R146	Voltage divider resistor	Same as R140	-63288							-		-		-	
R147	Voltage divider resistor	Same as R140	-63288							-		-		-	
R148	Voltage divider resistor	Same as R140	-63288							-		-		-	
R149	Voltage divider resistor	Same as R140	-63288							-		-		-	
R150	Voltage divider resistor	Same as R140	-63288							-		-		-	
R151	Voltage divider resistor	Same as R140	-63288							-		-		-	
R152	Voltage divider resistor	Same as R140	-63288							-		-		-	
R153	Voltage divider resistor	Same as R140	-63288							-		-		-	
R154	Voltage divider resistor	Same as R140	-63288							-		-		-	
R155	Voltage divider resistor	Same as R140	-63288							-		-		-	
R156	Voltage divider resistor	Same as R140	-63288							-		-		-	
R157	Voltage divider resistor	Same as R140	-63288							-		-		-	
R158	Voltage divider resistor	Same as R140	-63288							-		-		-	
R159	Voltage divider resistor	Same as R140	-63288							-		-		-	
R160	Voltage divider resistor	Resistor, composition, 200,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5257	228	1	1		2		3	R160, R161
R161	Voltage divider resistor	Same as R160	-63288							-		-		-	

- For spares see reference given in "Description" column

Revised 3-21-44

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		SWITCHES, INTERLOCKS AND THERMOSTATS													
S101	Safety door switch	Switch, interlock, 10 a @ 125 v ac wiping contacts, male parts silver plated.			6	LD4600	28-5072G1	234	1	1		1		1	S101
S107		Speed governor assembly.			92	DS-1X	28-5094P1			0		0		0	S107
S107A		Rotating contactor assembly.			92		28-5095P1	236	1	1		1		2	S107A
S107B		Set (2) brush & spring assemblies.			92		103-5071P1	237	1	5		10		20	S107B
S107C		Brush holder & insulating disc.			92		103-5072P1	238	1	1		4		6	S107C
S107-1		Speed governor assembly.			92	DS-1X-N	28-5094P2			0		0		0	S107-1
S107-1A		Rotating contactor assembly.			92		29-5095P2	242	1	1		1		2	S107-1A
S107-1B		Set (2) brush spring assemblies.			92		103-5071P2	243	1	5		10		20	S107-1B
S107-1C		Brush holder & insulating disc.			92		103-5072P2	244	1	1		4		6	S107-1C
		TRANSFORMERS													
T103	IFF trigger transformer	Transformer IFF trigger: Wind. No. Turns Wire Size DC Res. Volts Pri. 13 .020x.07HF .045 −40 Sec. #1 13 .020x.07HF .045 +40 Wt. 12 oz.		RE 13A 554D	28	UX-8442	92-370G1	249	1	1		2		3	T103
T104	VR102 plate & filament transformer	Transformer, Plate and Filament: Pri. 115/400/1ϕ Wind. No. Turns Wire Size DC Res. Volts Amps. Test V r.m.s. Pri. 434½ 26E 5.5 115 .309 1275 Sec. #1 221½ 39E 72 55 0.01 1275 Sec. #2 442 39E 145 110 0.01 1275 Sec. #3 25 22E 0.17 6.3 1.0 1275 Sec. #4 10 2x17E .013 2.5 7.0 1275 Sec. #2 and Sec. #4 CT. Pri. rated: 34 va (approx.) Wt. 2 lbs., 10 oz.		RE 13A 554D	28	UX-8352A	92-192G2	250	1	1		2		3	T104
T105	Charging transformer	Transformer, Plate: Pri. 110/115/120/400~/1ϕ Wind. NO. Turns Wire Size DC Res. Volts Amps Test V r.m.s. Pri. 185 19E .8 110 2.7 1780 Sec. #1 4000½ 31HF 360 6500 .055 Pri. rated: 310 va (approx.)			28	UX-8485A	92-587G1	251	1	1		1		1	T105

0 No spares furnished

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		TRANSFORMERS (Cont'd)													
T106	Filament transformer	Transformer, Filament: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 880 26E 100 115 .260 1780 Sec. #1 40 14E .05 5 5 18,500 Pri. rated: 30.2 va (approx.)			28	UX-8486A	92-586G1	252	1	1		2		3	T106
		* VACUUM AND GASEOUS DISCHARGE TUBES													
V101	Half wave rectifier for V103 base	Twin triode, low Mu amplifier.	6SN7-GT		29	6SN7-GT	90-5051			2		3		0	V101
V102	Full wave rectifier	Twin diode - glass tube.	6H6-GT		29	6H6-GT	90-5048P2			2		3		0	V102
V103	Half wave rectifier	Gas filled triode.			65	C1B	90-5081			2		3		0	V103
V104	High voltage regulator	Single diode.			28	705A	90-5042			2		3		0	V104
		SOCKETS AND FUSE HOLDERS													
X101	Socket for V101	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts and mtg.			2	RSS-8M	82-5012P3	257	1	1		1		1	X101,X102
X102	Socket for V102	Same as X101								-		-		-	
X103	Socket for V103	Vacuum tube socket, 4 contacts, ceramic wafer, silvered contacts and mtg.			2	RSS-4M	82-5016P2	259	1	1		1		1	X103,X104
X104	Socket for K110	Same as X103								-		-		-	
X105	Socket for V104	Vacuum tube socket, 4 contacts, special ceramic with lock for 705A tube, silver plated contacts.			47	WE 705A	82-5005	260	1	1		1		1	X105
		ASSEMBLIES													
Z101	Modulator pulse forming line	Pulse line, 15 kv, type A1.0 Microsec. 400 ~ repetition frequency.			33	15-A-1.00-400-50	92-5080	265	1	1		2		3	Z101
Z103	Tail damping assembly	Special resistor (thryite).			28		18A1-1	266	1	1		2		2	Z103
Z104	RF filter	Filter assembly.			28		4D19-167	267	1	1		2		2	Z104

0 No spares furnished
* Packed in wood box - see Packing List
- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		MECHANICAL SPARES - MOTOR-ALTERNATOR AND MODULATOR													
		Captive screw.					9-5071P1	272		0		2		2	
		Captive screw.					9-5118P4	273		0		2		2	
		Tubing (14′ min.)					39-5033P1	274		0		1		2	
		Bowl					94-5012	275	1	1		4		8	
		Washer					3D1-105P1	276		0		1		1	
		Washer					3D1-104P1	277		0		1		1	
		Washer					3D1-151P1	278		0		1		1	
		Washer					3D1-150P1	279		0		1		1	
		Motor coupling					12-5098G2	280		0		1		1	
		Washer, cork 1" sq. x 1/32" thick with two 3/16" holes.					87-19	281	1	1		2		4	
		Grommet					4D1-153	282	1	1		2		4	
		Grommet					4-5044	283	1	1		2		4	
		Grommet					4-5045	284	1	1		2		4	
		Grommet					4-5046	285	1	1		2		4	
		Grommet					4D16-141	286	1	1		2		4	
		Grommet					4D17-142	287	1	1		2		4	
		Grommet			82	K14690	4-5038	288	1	1		2		4	
		Gasket					3D3-118	289	1	1		2		4	
		Gasket					3D3-119	290	1	1		2		4	
		Gasket					3D19-161	291	1	1		2		4	
		Shock mount					39-5054	292	1	1		1		2	
		Shock mount			91	Type 40	39-5024	293	1	1		1		2	
		Insulator, ceramic, 1" sq., 2½" long, tapped 8-32-			40	#1063	22-5054	294	1	1		1		2	
		Shaft lock					31-5013P2	295	1	1		1		1	
		Andok "C" grease.					23-5038P2	296	1	1		3		6	
		MECHANICAL SPARES - SPARK GAP													
		Spark Gap adaptor Kit "A".			28	WX-5669	33B-142G1	346	1	1		0		0	
		Spark Gap adaptor Kit "A".					33B-142G2	346A		0		2		3	
		Connector lead assembly			28		33B12-108G2	325	1	1		2		3	
		Mounting studs			28		33B-44P1	326		0		6		12	
		Electrode ring (7 pin).			28		33B-12	327	1	3		6		12	

0 No spares furnished

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR MOTOR-ALTERNATOR AND MODULATOR ASSEMBLY
WX-5276A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES - SPARK GAP (Cont'd)													
		Ring			28		33B-41P1	328		0		2		4	
		Shim			28		33B-42P1	329		0		1		3	
		Shim			28		33B-42P2	330		0		1		3	
		Shim			28		33B-42P3	331		0		1		3	
		Flexible coupling (Gap)			28		105-5704P1	332		0		1		1	
		Flexible coupling (Alternator)			28		105-5705P1	333		0		1		1	
		Alignment block			28		105-5706P1	334	1	1		2		6	
		Wrench			28		33B-45P1	335		0		1		2	
		Wrench			28		33B-43P1 *	336	1	1		1		2	
		Set (2) brush and spring assemblies			28		103-5104	337	1	5		10		20	
		Internal retainer ring			28		87-5047P6	338		0		4		6	
		Loading spring			106	#S-10	36-5115	339		0		4		6	
		Bearing			106	77500	102-5114	340		0		2		2	
		Stationary electrode			28		33A4-28P1	341	1	4		8		16	
		Machine screw, special			28		33A4-20P1	342		0		0		1	
		Captive screw			28		33A5-27P1	343		0		1		2	
		Bearing spacer			28		33A1-79P1	344		0		1		1	
		Gauge for electrode spacing			28		33A18-118P1	345	1	1		1		2	
		Insert					33B10-138	347		0		6		12	
		Insert					33B10-139	348		0		6		12	
		Woodruff key					105-5673	349		0		2		2	

0 No spares furnished
* Pack with Tag #327

Revised 3-21-44

TABLE II

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-20286 RECTIFIER POWER UNIT

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
NAVY TYPE CRP-20286 RECTIFIER POWER UNIT															
		Rectifier Power Unit	-20286		28	RX-1149		401		0		0		1	
CAPACITORS															
C201	1st filter capacitor, positive side	Capacitor, paper, 4 mfd., ±10%, 600 v dc wkg.		RE 48A 488D	33	2538-3	35-5094	411	2	1		2		3	C201, C202, C204
C202	2nd filter capacitor, positive side	Same as C201								-		-		-	
C203	1st filter capacitor, negative side	Capacitor, paper, 4 mfd., ±10%, 1000 v dc wkg.		RE 48A 488D	33	2538-6	35-5098	413	2	1		2		3	C203
C204	2nd filter capacitor, negative side	Same as C201								-		-		-	
TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS															
E201	Motor-Alternator input	Terminal strip, bakelite barrier type, 8 solder terminals with 6-32 x ¼" binder head screws.			21	8-141-¾W	47-5021P3	419		0		0		1	E201, E202, E203, E204, E205
E202	Indicator output	Same as E201								-		-		-	
E203	Indicator output	Same as E201								-		-		-	
E204	Trans.-Receiver output	Same as E201								-		-		-	
E205	Trans.-Receiver output	Same as E201								-		-		-	
FUSES															
F201	Transformer fuse for Transmitter-Receiver	Fuse, 1 a, 250 v, length 2", ferrule dia. 9/16".			57	25001	26-5035	428	2	20		40		100	F201, F202, F204
F202	Blower motor fuse	Same as F201								-		-		-	
F203	Transformer fuse for Power Supply	Fuse, 2 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25002	26-5036	430	2	10		20		50	F203
F204	Fuse for E303 Solenoid	Same as F201								-		-		-	
F206	Fuse for Modulator	Fuse, 3 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25003	26-5037	433	2	10		20		50	F206

0 No spares furnished
- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-20286 RECTIFIER POWER UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		CONTACTORS AND RELAYS													
K201	Synchronizing relay for synchro	Relay, DPDT, 24 v dc coil, contacts rated for 5 a, @ 115 v, 400 ~.			75	BO6D35	71-5015	450	2	1		2		3	K201
		INDUCTORS AND CHOKES													
L201	Filter choke	Reactor, 1.3 hy. min. ind. @ 130 ma dc and 3 v r.m.s., 60 ~ ac. Test 1200 v r.m.s. 1200½ tirms #30E wire, 52 Ω max. dc res. Wt. 15½ oz.		RE 13A 554D	28	UX-7817A	92-406	455	2	1		1		1	L201, L202
L202	Filter choke	Same as L201								-		-		-	
L203	Filter choke	Reactor, 8 hy. min. ind. @ 60 ma dc and 3 v r.m.s., 60 ~ ac. Test 1200 v r.m.s. 3000½ turns #34E wire, 278 Ω max. dc res. Wt. 1 lb.		RE 13A 554D	28	UX-7818	92-407	457	2	1		1		1	L203
		RESISTORS													
R201A	Dropping resistor, general i-f B supply	Resistor, wirewound 1850 Ω ±5%, Style D, Grade 1, Class I		RE 13A 372J Style D	18		80-5482	475	2	1		2		3	R201A
R202A	Video and last i-f stage dropping resistor	Resistor, wirewound 800 Ω ±5%, Style E, Grade 1, Class II.	-63984-E	RE 13A 372J Style E	18		80-5060	476	2	1		2		3	R202A
R203	Bleeder resistor, negative side	Resistor, composition, 100,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5234	477	2	1		2		3	R203
R204	Bleeder resistor, negative side	Resistor, composition, 70,000 Ω ±10%, 1 watt.	-63288	RE 13A 372J	34	CM-1	80-5232	478	2	1		2		3	R204
R205	Regulator resistor, 255 v output	Resistor, wirewound 9000 Ω ± 5%, Style D, Grade 1, Class II.	-63089-E	RE 13A 372J Style D	18		80-5335	479	2	1		2		3	R205
R206	Regulator resistor, 360 v output	Resistor wirewound 7500 Ω ±5%, Style D, Grade 1, Class II	-631532-E	RE 13A 372J Style D	18	4-7/16L-20-13	80-5254	480	2	1		2		3	R206
R207	Bleeder resistor, positive side	Resistor, composition, 500,000 Ω ±10%, 1 watt.	-63288	RE 13A 372J	34	CM-1	80-5240	481	2	1		2		3	R207
R212	Relay dropping resistor	Resistor, wirewound, 800 Ω ±5%, Style E, Grade 1, Class 1.	-63984-F		33		80-5267	483	2	1		2		3	R212, R213
R213	Relay dropping resistor	Same as R212	-63984-F							-		-		-	

- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-20286 RECTIFIER POWER UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		SWITCHES, INTERLOCK AND THERMOSTATS													
S201	Interlock	Switch, interlock, 10 a @ 125 v ac, wiping contacts, male parts silver plated.			6	LD4600	28-5072G1	488	2	1		1		1	S201
		TRANSFORMERS													
T201	Receiver power supply transformer	Transformer, Plate and Filament: Pri. 115/400/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. #1 360 25E 4.0 115 .87 1780 Pri. #2 360 25E 4.0 115 .87 1780 Sec. #1 2800 30E 145 800 .085 1780 Sec. #2 17 17E .058 5 3 1780 Sec. #3 2160 30E 108 390 0.1 1780 Sec. #4 17 17E .058 5 3 1780 Pri. rated: 115 va (approx.) Elec. shield Sec. #1 & Sec. #3 CT. Wt. 2 lbs., 12 oz.		RE 13A 554D	28	UX-7779E	92-404	496	2	1		2		3	T201
		* VACUUM AND GASEOUS DISCHARGE TUBES													
V201	Positive side rectifier	Full wave rectifier.	5U4-G		29	5U4-G	90-5056			2		3		0	V201, V202
V202	Negative side rectifier	Same as V201	5U4-G							-		-		-	
V205	Regulator tube, 225 v output	Voltage regulator.	-38250		29	(VR 150-30)	90-5061			2		3		0	V205
V206	Regulator tube, 225 v output	Voltage regulator	-38205		29	(VR 105-30)	90-5058			2		3		0	V206
V207	Regulator tube, 360 v output	Same as V206	-38205		29					-		-		-	
		SOCKETS AND FUSE HOLDERS													
X201	Socket for V201	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts.			2	SS-8M	82-5012P2	517	2	1		1		1	X201, X202, X205, X206, X207
X202	Socket for V202	Same as X201								-		-		-	
X205	Socket for V205	Same as X201								-		-		-	
X206	Socket for V206	Same as X201								-		-		-	
X207	Socket for V207	Same as X201								-		-		-	
		MECHANICAL SPARES													
		Shock mount			28		3F1-10P1	575	2	1		1		2	
		Captive nut					3-5064P1	576		0		2		2	

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wood boxes - see Packing Lists

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER													
		Radar Transmitter-Receiver	-43ABY		28	WX-4833	3B-1	601		0		0		1	
		Radar Receiver	-46ACA-1		28	WX-5229	4B2-4			0		0		0	
		MOTORS AND SYNCHRO UNITS													
B301		Motor for blower 115 v.			28		1-4B	607	2	1		2		3	B301
B301B		Set (2) brushes.			11		103-5032	608	2	5		10		20	B301B
B301C		Set (2) brush holder caps.			11		103-5022	609		1		4		6	B301C
		CAPACITORS													
C301	Input coupling capacitor	Capacitor, mica, .00001 mfd., ±5%, 500 v dc wkg.	-48710-D5	RE 48A 148 RE 48A 154F	32	MOSCW-5-41-5	35-5095	622	2	1		1		1	C301, C324
C302	Input by-pass capacitor	Capacitor, mica, .001 mfd., ±10%, 300 v dc wkg.	-481070G-10	RE 48A 154F	32	MOCW-1427-10	35-5086	623	2	1		1		1	C302, C305, C306, C308, C309, C311, C312, C314, C315, C317, C318, C320, C321, C336, C337, C338, C339, C340, C351
C305	V301 cathode by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C306	V301 plate by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C307	V302 coupling capacitor	Capacitor, mica, .0001 mfd., ±5%, 500 v dc wkg.	-48674-5	RE 48A 154F	32	MOCW-1416-5	35-5106	626	2	1		1		1	C307, C310, C313, C316, C319, C323, C352
C308	V302 cathode by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C309	V302 plate by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C310	V303 coupling capacitor	Same as C307	-48674-5							-		-		-	
C311	V303 cathode by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C312	V303 plate by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C313	V304 coupling capacitor	Same as C307	-48674-5							-		-		-	
C314	V304 cathode by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C315	V304 plate by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C316	V305 coupling capacitor	Same as C307	-48674-5							-		-		-	
C317	V305 cathode by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C318	V305 plate by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C319	V306 coupling capacitor	Same as C307	-48674-5							-		-		-	
C320	V306 cathode by-pass capacitor	Same as C302	-481070C-10							-		-		-	
C321	V306 screen by-pass capacitor	Same as C302	-481070C-10							-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		CAPACITORS (Cont'd)													
C322	V306 plate by-pass capacitor	Capacitor, mica, .001 mfd., ±20%, 500 v dc wkg.			32	MWCW-1227	35-5105	641	2	1		1		1	C322
C323	V307 coupling capacitor	Same as C307	-48674-5							-		-		-	
C324	V307 anode filter capacitor	Same as C301	-48710-D5							-		-		-	
C325	V308 coupling capacitor	Capacitor, mica, .01 mfd., ±10%, 300 v dc wkg.	-48848-C10	RE 48A 143F RE 48A 154F	32	MWCW-1249-10	35-5096	643	2	1		1		1	C325, C328, C329, C330, C331 C332, C333, C334, C335
C327A B C	Video by-pass capacitor Video by-pass capacitor Video by-pass capacitor	Capacitor, paper, 3 x .1 mfd., ±20%, 600 v dc wkg.	-48709-A20	RE 48A 138C RE 48A 488D	33	2529-4	35-5092	645	2	1		2		3	C327
C328	V301 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C329	V302 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C330	V303 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C331	V304 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C332	V305 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C333	V306 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C334	V307 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C335	V308 heater by-pass capacitor	Same as C325	-48848-C10							-		-		-	
C336	Line filter capacitor	Same as C302	-481070C-10							-		-		-	
C337	Line filter capacitor	Same as C302	-481070C-10							-		-		-	
C338	V302 r.f. filter capacitor	Same as C302	-481070C-10							-		-		-	
C339	105 v r.f. filter capacitor	Same as C302	-481070C-10							-		-		-	
C340	240 v r.f. filter capacitor	Same as C302	-481070C-10							-		-		-	
C341	Phase shift capacitor	Capacitor, mica, .001 mfd., ±10%, 2500 v dc wkg.	-48764-10	RE 48AA 112N RE 48A 154F	32	XCW2.5-21-10	35-5087	659	2	1		1		1	C341
C342	Heater by-pass capacitor	Capacitor, paper, .02 mfd., +20%-10%, 600 v dc wkg.			33	PX24A	35-5090	660	2	1		2		3	C342, C343
C343	Heater by-pass capacitor	Same as C342								-		-		-	
C344	Metering circuit by-pass	Capacitor, paper, 0.5 mfd., ±10%, 400 v dc wkg.	-48205-A	RE 48A 129E RE 13A 488D	33	2528-2	35-5052	662	2	1		2		3	C344, C347
C345	Bias by-pass capacitor	Capacitor, mica, .025 mfd., ±10%, 1200 v dc wkg.		RE 48A 154F	30	A-2125	35-5102	663	2	1		1		1	C345
C347	Thermostat by-pass capacitor	Same as C344	-48205-A							-		-		-	
C348	Reflector plate filter	Capacitor, mica, .001 mfd., ±10%, 500 v dc wkg.	-48983-10	RE 48A 143F RE 48A 154F	32	MWCW-1227-10	35-5036	665	2	1		1		1	C348, C349, C350, C353
C349	Cathode filter capacitor	Same as C348	-48983-10							-		-		-	
C350	Cathode filter capacitor	Same as C348	-48983-10							-		-		-	
C351	V301 by-pass capacitor	Same as C302	-481070C-10							-		-		-	

- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		CAPACITORS (Cont'd)													
C352	Video plate by-pass capacitor	Same as C307	-48674-5							-		-		-	
C353	Video screen by-pass capacitor	Same as C348	-48983-10							-		-		-	
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E301	Pulse line terminal support	Insulator, ceramic stand-off 2" long, 1" square tapped 8-32.			40	1062	22-5023	680	2	1		1		2	E301
E302	Transmitter-Receiver	Terminal strip, barrier type, 6 solder terminals with 5-40 x 3/16" binder head screws.			21	6-140-¾W	47-5049P3	681		0		0		1	E302
E303	Waveguide shorting device	Solenoid assembly.			28		3B2-321G1	682	2	1		2		3	E303
E304	Blower motor terminal strip	Terminal strip, bakelite barrier type, 3 solder terminals with 5-40 x 3/16" binder head screws.			21	3-140-¾W	47-5034P3	683		0		0		1	E304
E305	Magnet for V311	Magnet, permanent, flux density, 1825 ±25 Gauss.			7	443MS	120-5003P1	684		0		1		2	E305
		Insulator, ceramic stand-off, 2½" long, ½" dia. tapped 8-32, ½" deep at each end.			40	1004	22-5048	690	2	1		1		2	
		Insulator, ceramic stand-off, 1" long, ½" dia. tapped 6-32, 3/8" deep at each end.			40	1000	22-5015P1	691	2	1		1		2	
		RECEPTACLES													
J301	Receiver input connector	Receiver input connector.			28		6-5173G1	711	2	1		1		2	J301, J302
J302	Mixer current metering connector	Same as J301								-		-		-	
J303	Receiver output connector	Co-axial cable connector			28		6-5156G1	713	2	1		1		2	J303
J304	Oscillator output coupling connector	Oscillator cavity output connector.			28		6-5152G1	714	2	1		1		2	J304
J305	Transmitter current metering jack	Receptacle, tip jack.			105	417	76-5001	715	2	1		1		2	J305
J307	Cable connection to transmitter	Terminal jack panel.			28		6-4B	716	2	1		1		2	J307
J307A	Transmitter jack	Receptacle, jack, banana type.			35	152347	51-5701G3	717	2	2		4		8	J307A

0 No spares furnished
- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART									SPARES						
									EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		INDUCTORS AND CHOKES													
L301	Input inductor	Inductor, RF, 9 turns #26E wire on 7/16" dia. ceramic form.			28		51-5880G1	727		0		1		1	L301
L302	V301 grid inductor	Inductor, RF, 12 turns #26E wire on 7/16" dia. ceramic form.			28		51-5880G2	728		0		1		1	L302, L303, L304, L305, L306 L307, L308
L303	V302 grid inductor	Same as L302								-		-		-	
L304	V303 grid inductor	Same as L302								-		-		-	
L305	V304 grid inductor	Same as L302								-		-		-	
L306	V305 grid inductor	Same as L302								-		-		-	
L307	V306 grid inductor	Same as L302								-		-		-	
L308	V307 coupling inductor	Same as L302								-		-		-	
L309	V307 output filter choke	Reactor, RF choke, 150 μh. min. ind. @ 5 ma dc, 1 πwound on 3/16" x 7/16" form with axial leads.			31	12543	92-5079P1	735	2	1		1		1	L309, L322
L310	V301 heater choke	Reactor, RF choke, 3/16" x 5/8" form with axial leads. 1st layer 21-23 turns #24A wirewound right hand. 2nd layer 12-14 turns #24E wirewound left hand.			31	12734	92-5078P1	736		0		1		1	L310, L311, L312, L313, L314, L315, L316, L317, L318, L319, L320, L321
L311	V302 heater choke	Same as L310								-		-		-	
L312	V303 heater choke	Same as L310								-		-		-	
L313	V304 heater choke	Same as L310								-		-		-	
L314	V305 heater choke	Same as L310								-		-		-	
L315	V306 heater choke	Same as L310								-		-		-	
L316	V307 heater choke	Same as L310								-		-		-	
L317	V308 heater choke	Same as L310								-		-		-	
L318	T301 line filter choke	Same as L310								-		-		-	
L319	T301 line filter choke	Same as L310								-		-		-	
L320	V310 heater choke	Same as L310								-		-		-	
L321	V310 heater choke	Same as L310								-		-		-	
L322	Video plate choke	Same as L309								-		-		-	
		PLUGS AND PROBES													
P301	Receiver input plug	Connector			28		6-5157G1	759	2	1		1		2	P301, P303, P304
P302	Short circuiting plug	Connector, short circuiting.			28		6-5150G1	760	2	1		1		2	P302
P303	Receiver output plug	Same as P301								-		-		-	
P304	Oscillator output plug	Same as P301								-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

Revised 3-21-44

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		PLUGS AND PROBES (Cont'd)													
P307	Terminal plug panel	Terminal plug panel.			28		7-4B	764	2	1		1		2	P307
P307A		Plug, banana, screw type and hardware.			35	152346	51-5701G4	765	2	2		4		8	P307A
		RESISTORS													
R301	Mixer current decoupling resistor	Resistor, composition, 100 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5204	771	2	1		2		3	R301
R303	V301 cathode resistor	Resistor, composition, 50 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5200	773	2	1		2		3	R303, R306, R309, R312, R315
R304	V301 plate resistor	Resistor, composition, 1000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5209	774	2	1		2		3	R304, R307, R310, R313, R316, R319
R305	V301 decoupling resistor	Resistor, composition, 250 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5205	775	2	1		2		3	R305, R308, R311, R314, R317, R320, R321, R328, R330, R331, R333, R340
R306	V302 cathode resistor	Same as R303	-63355							-		-		-	
R307	V302 plate resistor	Same as R304	-63355							-		-		-	
R308	V302 decoupling resistor	Same as R305	-63360							-		-		-	
R309	V303 cathode resistor	Same as R303	-63355							-		-		-	
R310	V303 plate resistor	Same as R304	-63355							-		-		-	
R311	V303 decoupling resistor	Same as R305	-63360							-		-		-	
R312	V304 cathode resistor	Same as R303	-63355							-		-		-	
R313	V304 plate resistor	Same as R304	-63355							-		-		-	
R314	V304 decoupling resistor	Same as R305	-63360							-		-		-	
R315	V305 cathode resistor	Same as R303	-63355							-		-		-	
R316	V305 plate resistor	Same as R304	-63355							-		-		-	
R317	V305 decoupling resistor	Same as R305	-63360							-		-		-	
R318	V306 cathode resistor	Resistor, composition, 75 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5202	788	2	1		2		3	R318
R319	V306 plate resistor	Same as R304	-63355							-		-		-	
R320	V306 screen decoupling resistor	Same as R305	-63360							-		-		-	
R321	V306 plate decoupling res.	Same as R305	-63360							-		-		-	
R322	V307 diode load resistor	Resistor, composition, 5000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5215	792	2	1		2		3	R322
R323	V308 grid resistor	Resistor, composition, .25 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5238	793	2	1		2		3	R323
R324		Resistor, composition, 100,000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5235	794	2	1		2		3	R324

- For spares see reference given in "Description" column

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd)													
R325		Resistor, composition, 25,000 Ω ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5227	795	2	1		2		3	R325
R328	V302 decoupling resistor	Same as R305	-63360							-		-		-	
R329	105 v decoupling resistor	Resistor, composition, 50 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5201	796	2	1		2		3	R329, R332
R330	240 v decoupling resistor	Same as R305	-63360							-		-		-	
R331	V302 decoupling resistor	Same as R305	-63360							-		-		-	
R332	105 v decoupling resistor	Same as R329	-63288							-		-		-	
R333	240 v decoupling resistor	Same as R305	-63360							-		-		-	
R334	Keep-alive circuit dropping res.	Resistor, composition, 2 MΩ ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5245	802	2	1		2		3	R334
R335	Phase shift resistor	Resistor, composition, 200,000 Ω ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5257	803	2	1		2		3	R335, R341
R336	Transmitter current metering resistor	Resistor, composition, 1000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5210	804	2	1		2		3	R336
R337	Transmitter bias resistor	Resistor, composition, 10,000 Ω ±10%, 2 watts.	-63474	RE 13A 372J	20	BT-2	80-5071	805	2	1		2		3	R337, R338, R342, R343, R344, R345, R346
R338	Transmitter bias resistor	Same as R337	-63474							-		-		-	
R339	Reflector plate decoupling res.	Resistor, composition, 10,000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5218	807	2	1		2		3	R339
R340	Cathode filter resistor	Same as R305	-63360							-		-		-	
R341	Phase shift resistor	Same as R335	-63288							-		-		-	
R342	Transmitter bias resistor	Same as R337	-63474							-		-		-	
R343	Transmitter bias resistor	Same as R337	-63474							-		-		-	
R344	Transmitter bias resistor	Same as R337	-63474							-		-		-	
R345	Transmitter bias resistor	Same as R337	-63474							-		-		-	
R346	Transmitter bias resistor	Same as R337	-63474							-		-		-	
		SWITCHES, INTERLOCKS AND THERMOSTATS													
S301	Interlock	Switch, interlock, 10 a @ 125 v ac, wiping contacts, male parts silver plated.			6	LD 4600	28-5072G1	829	2	1		1		1	S301
S302	Transmitter-Receiver over-load thermostat	Thermoswitch, cartridge type, opens at 85 °C, 115 v ac.			13	4-732C	28-5073P1	828	2	1		2		4	S302

Revised 3-21-44

- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		TRANSFORMERS													
T301	Receiver heater transformer	Transformer, Filament: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps. / Test V r.m.s. Pri. 350 28E 9.2 115 .22 1780 Sec. 20 16E .045 6.3 3.7 1780 Pri. rated: 25 va (approx.) Elec. shield. Wt. 1 lb., 4 oz.		RE 13A 554D	28	UX-9193	92-405G2	833	2	1		2		3	T301
T302	High voltage pulse transformer	Transformer: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 645 34HF .34 115 0.143 1200 Sec. 59 28HF .29 9.7 1.5 1200 6-2 73 22HF .63 7-3 73 22HF .63 1-G 18 22HF .044 Pri. rated: 16.4 va (approx.) Wt. 7¾ lbs.		RE 13A 554D	28	WX-4298E	92-401G1	834	2	1		2		3	T302
T303	Keep-alive and oscillator heater transformer	Transformer, Plate and Filament: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps. / Test V r.m.s. Pri. 770 33E 43 115 0.05 1780 Sec. #1 7111 40E 2700 1000 0.0025 8kv Sec. #2 46 25E 0.66 6.0 0.45 1780 Pri. rated: 5.8 va (approx.) Elec. shield. Wt. 2 lbs., 4 oz.		RE 13A 554D	28	UX-7812B	92-362G1	835	2	1		2		3	T303
		*** VACUUM AND GASEOUS DISCHARGE TUBES													
V301	1st i-f amplifier	Television, amp. pentode	6AC7		29	6AC7/1852	90-5072		2	2		3		0	V301, V302, V303, V304, V305, V306, V307, V308
V302	2nd i-f amplifier	Same as V301	6AC7							-		-		-	
V303	3rd i-f amplifier	Same as V301	6AC7							-		-		-	
V304	4th i-f amplifier	Same as V301	6AC7							-		-		-	
V305	5th i-f amplifier	Same as V301	6AC7							-		-		-	
V306	6th i-f amplifier	Same as V301	6AC7							-		-		-	
V307	Second detector	Same as V301	6AC7							-		-		-	
V308	Output limiter	Same as V301	6AC7							-		-		-	
*V309	Duplexing tube	Gas discharge tube.			19	721A	90-5075		2	3		6		0	V309
*V310	Receiver local oscillator	Reflection type oscillator.			28	707B	90-5077		2	3		6		0	V310
V311	High frequency oscillator	Transmitter tube			28	2J26**	90-5078)		2	3		6		0	V311
V311	High frequency oscillator	Transmitter tube.			28	2J27**	90-5079)								V311

0 No spares furnished
- For spares see reference given in "Description" column
* See Z301 and Z303
** Mfr. Desig. indicates frequency
*** Shipped in wood box - see Packing List

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		SPECIAL CABLES													
W301	Pulse cable	Cable, armored coaxial (50′ min.)	RG-14/U		16	RG-14/U (armored)	73-5087P2	839	*	1		2		4	W301
W302	Receiver output jack	6½" cable assembled on J303			28		17-3B	840	2	1		1		2	W302
		SOCKETS AND FUSE HOLDERS													
X301	Socket for V301	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts.			2	SS-8M	82-5012P2	843	2	1		1		1	X301,X302,X303,X304,X305 X306,X307,X308
X302	Socket for V302	Same as X301								-		-		-	
X303	Socket for V303	Same as X301								-		-		-	
X304	Socket for V304	Same as X301								-		-		-	
X305	Socket for V305	Same as X301								-		-		-	
X306	Socket for V306	Same as X301								-		-		-	
X307	Socket for V307	Same as X301								-		-		-	
X308	Socket for V308	Same as X301								-		-		-	
X310	Socket for V310	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts and mounting.			2	RSS-8M	82-5012P3	848	2	1		1		1	X310
		CRYSTALS													
Y301	Crystal for mixer	Crystal rectifier capsule, metal part gold-plated.			19	R7011	122-5001	850	2	10		20		50	Y301
		ASSEMBLIES													
Z301	Transmitter, RF system and duplexing cavity (RF301) with duplexing tube (V309)	Comprises V309 and RF301.			28		15-3B	853		0		1		2	Z301
Z302	Mixer system	Comprises Y301, RF302 and cables with connectors P301 and P304.			28	WX-4755	91-5081G2	854		0		1		2	Z302
Z303	Local oscillator assembly	Comprises J304, V310 and RF303.			28	WX-3879	51-5026G2	855		0		1		2	Z303
Z304	RF coupling - waveguide to Transmitter	Special waveguide and choke assembly.			28		11-3B	856		0		1		2	Z304
		SPECIAL RF ASSEMBLIES													
RF301	RF system with duplexing cavity	Special RF assembly.			28					0		0		0	RF301
RF302	Mixer RF unit	Special RF assembly.			28					0		0		0	RF302
RF303	Oscillator tube cavity	Special RF assembly.			28					0		0		0	RF303
RF304		V311 output tip.			28					0		0		0	RF304

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wood box

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ABY RADAR TRANSMITTER-RECEIVER

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		MECHANICAL SPARES													
		Shock mount			66	200-P20	39-5037	865	2	1		1		2	
		Gasket					3B8-41P1	866	2	1		2		4	
		Gasket					3B10-62P1	867	2	1		2		4	
		Gasket					3B10-61P1	868	2	1		2		4	
		Gasket					3B-54	869	2	1		2		4	
		Gasket					3B-52	870	2	1		2		4	
		Gasket					3B-51	871	2	1		2		4	
		Gasket					3B-283	872	2	1		2		4	
		Gasket					3B-69	873	2	1		2		4	
		Captive screw					3B13-204	874		0		2		2	
		Captive screw					3B10-63	875		0		2		2	
		Captive screw					3B13-94	876		0		2		2	
		Captive screw					3B10-64P1	877		0		2		2	
		Captive screw					9-5118P2	878		0		2		2	
		Screw assembly					3A15-180	879		0		1		2	
		Plexiglass window for Z304					3B8-42P1	880	2	1		2		3	
							3B-366P1	886	2	1		2		4	
		Grommet													
		Gasket					3B8-373P1	888	2	1		2		4	
	For armored cable	Pulse cable stuffing tube assembly					3B61-411	889		0		1		2	
	For unarmored cable	Pulse cable stuffing tube assembly					3B62-416	890		0		1		2	

0 No spares furnished

CONFIDENTIAL

TABLE II

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR															
		Plan Position Indicator	-55ADQ		28	WX-4804A	3C17-191	901		0		0		1	
MOTORS AND SYNCHRO UNITS															
B401		Motor Synchro, 400~, 90-115 v.			14	Type 5SF	115-5021	906		0		2		3	B401
CAPACITORS															
C401	V401A trigger capacitor	Capacitor, mica, .00025 mfd., ±10%, 500 v dc wkg.	-48690	RE 48A 148C RE 48A 154F	9	Type 5W	35-5084	911	2	1		1		1	C401
C402	V401 timing capacitor	Capacitor, mica, .002 mfd., ±5%, 500 v dc wkg.	-48856-5	RE 48A 143F RE 48A 154F	9	1WS5D2-5	35-5039	912	2	1		1		1	C402
C403A B C	V401B cathode by-pass capacitor C-Bias filter capacitor V401B cathode by-pass capacitor	Capacitor, paper, 3 x .1 mfd., ±20%, 600 v dc wkg.	-48709-A20	RE 48A 138C RE 48A 488D	33	2529-4	35-5092	913	2	1		2		3	C403
C404	V402A grid capacitor	Capacitor, paper, .02 mfd., +20%-10%, 600 v dc wkg.			33	PX24A	35-5090	914	2	1		2		3	C404, C416
C405	Sweep starting capacitor	Capacitor, mica, .000025 mfd., ±5%, 500 v dc wkg.			32	MCW-1406-5	35-5122	915	2	1		1		1	C405, C406
C406	Sweep starting capacitor	Same as C405								-		-		-	
C407	Sweep capacitor	Capacitor, silver mica, .00022 mfd., ±2% 500 v dc wkg.			31		35-5123	917	2	1		1		1	C407
C408	Sweep capacitor	Capacitor, silver mica, .0014 mfd., ±2%, 500 v dc wkg.		RE 48A 233A RE 48A 154F	31		35-5099	918	2	1		1		1	C408
C409	Sweep capacitor	Capacitor, silver mica, .006 mfd., ±3% 500 v dc wkg.			32	MWSW-5-26-3	35-5124	919	2	1		1		1	C409
C410	V403 cathode by-pass capacitor	Capacitor, mica, .001 mfd., ±10%, 500 v dc wkg.	-48983-10	RE 48A 143F RE 48A 154F	32	MWCW-1227-10	35-5036	920	2	1		1		1	C410
C411	Filter capacitor	Capacitor, paper, 4 mfd., ±10%, 600 v dc wkg.		RE 48A 488D	33	2528-3	35-5094	921	2	1		2		3	C411, C412, C413, C414, C415
C412	Filter capacitor	Same as C411										-		-	
C413	Filter capacitor	Same as C411								-		-		-	
C414	Filter capacitor	Same as C411								-		-		-	
C415	Filter capacitor	Same as C411								-		-		-	
C416	V402B grid capacitor	Same as C404								-		-		-	
C417	V404B grid capacitor	Capacitor, paper, .01 mfd., +20%-10%, 5600 v dc wkg.		RE 13A 488D	33	PX24A	35-5089	927	2	1		2		3	C417, C418, C419, C420, C422, C423
C418	V405A grid capacitor	Same as C417								-		-		-	
C419	V405B grid capacitor	Same as C417								-		-		-	
C420	V407 cathode capacitor	Same as C417								-		-		-	
C421	Intensity control by-pass cap.	Capacitor, paper, 2 mfd., ±10%, 600 v dc wkg.	-48403-B	RE 48A 129H RE 13A 488D	9	DYR-6200	35-5007	931	2	1		2		3	C421, C429

0 No spares furnished

- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		CAPACITORS (Cont'd)													
C422	V406A grid capacitor	Same as C417								-		-		-	
C423	V406B grid capacitor	Same as C417								-		-		-	
C426A B	High voltage filter capacitor High voltage filter capacitor	Capacitor, paper, .1x.1 mfd., ±10%, 7000 v dc wkg.		RE 48A RE 48A 488D	15	25F453	35-5091	934	2	1		2		3	C426
C427	V402A plate capacitor	Capacitor, paper, 0.5 mfd., ±10%, 600 v dc wkg.	-481223	RE 48A RE 48A 488D	9	DYR-6050	35-5054	935	2	1		2		3	C427
C428	Relative bearing flasher filter capacitor	Capacitor, mica, .001 mfd. ±10%, 300 v dc wkg.	-481070C-10	RE 48A 154F	32	MOCW-1427-10	35-5086	936	2	1		1		1	C428
C429	L405 supply by-pass capacitor	Same as C421	-48403-B							-		-		-	
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E401	Terminal strip for L405	Terminal strip, barrier type, 2 solder terminal with 5-40 x 3/16" binder head screws.			21	2-140-W	47-5047P2	942		0		0		1	E401
		Insulator, ceramic stand-off, ¾" long ½" dia. tapped 6-32 ¼" deep at each end.			40	1402	22-5045P2	947	2	1		1		2	
		Insulator, ceramic, ½" long, ½" dia. tapped 8-32, 3/16" deep at each end.			40	1400	22-5047	948	2	1		1		2	
		Insulator, ceramic stand-off, 1" long, ½" dia. tapped 8-32, 3/8" deep at each end.			40	1000	22-5015P2	949	2	1		1		2	
		Insulator, ceramic stand-off, 2" long, ½" dia. tapped 6-32, ½" deep at each end.			40	1003	22-5046P1	950	2	1		1		2	
		FUSES													
F401	Fuse for T403 primary	Fuse, 1 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25001	26-5035	953	2	20		40		100	F401
F402	Fuse synchro supply	Fuse, 5 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25005	26-5038	954	2	10		20		50	F402
F403	Main fuse	Fuse, 6 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25006	26-5043	955	2	10		20		50	F403
F404	Fuse T401-2-3 primary	Fuse, 2 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25002	26-5036	956	2	10		20		50	F404
		DIAL AND PILOT LIGHTS													
I401	PPI dial light	Dial light, 6 volts, 1 cp.		TS-53	15	Mazda #51	77-5001	960	2	2		4		6	I401, I402, I403, I404
I402	PPI dial light	Same as I401								-		-		-	
I403	PPI dial light	Same as I401								-		-		-	
I404	PPI dial light	Same as I401								-		-		-	

0 No spares furnished
- For spares see reference given in "Descriptøon" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RECEPTACLES													
J401	Indicator input jack assy.	Jack panel assembly.			28		3C31-282	970	2	1		1		2	J401
J401A	Indicator chassis jack	Receptacle, jack, banana type.			35	152347	51-5701G3	971	2	2		4		8	J401A
J402	PPI input jack assembly	Jack panel assembly.			28		3C1-322	972	2	1		1		2	J402
J402A	PPI jack assembly	Jack, banana rivet type and hdwe.			35	152073	51-5804G1	973	2	2		4		8	J402A
		CONTACTORS AND RELAYS													
K401	Synchronizing relay for synchro	Relay, DPDT, 24 v dc coil, contacts rated for 5 a, @ 115 v 400 ~.			75	BO6D35	71-5015	979	2	1		2		3	K401
		INDUCTORS AND CHOKES													
L401	Sweep choke	Reactor, 3 hy. min. ind. @ 35 ma dc and 3 v rms, 60~ ac. Test 1780 v rms 2500 turns #34E wire, 250 Ω max. dc res. Wt. 15 oz.		RE 13A 554D	28	UX-7725	92-402	983	2	1		1		1	L401
L402	Filter choke	Reactor, 1.28 hy. min. ind. @ 130 ma dc and 3 v rms 60~ ac. Test 1200 v rms 1200½ turns #30E wire, 57Ω max. dc res. Wt. 15 oz.		RE 13A 554D	28	UX-7776	92-403	984	2	1		1		1	L402,L403
L403	Filter choke	Same as L402								-		-		-	
L404	Plate choke	Reactor, 1 mh, min. ind. @ 100~ within ±5%.			31	12587	92-5081	986	2	1		1		1	L404
L405	Focus coil assembly	Reactor, magnetic focus coil assy.			28		3C36-297	987		0		1		2	L405
L406	Deflection coil	Reactor, magnetic deflection coil assy.			28		92-5085P2	988		0		1		2	L406
L406A		Deflection coil brush and spring.			15	BA36CA20	103-5010	989	2	2		6		10	L406A
L406B		Deflection coil brush cap.			28		3C2-57P1	990	2	1		4		6	L406B
L407	Video compensating choke	Reactor, RF choke 300 μh min. ind. @ 5 ma dc.			31	12730	92-5079P2	991	2	1		1		1	L407
		PLUGS AND PROBES													
P401	Indicator input plug assembly	Plug panel assembly.			28		3C32-283	1000	2	1		1		2	P401
P401A		Plug, banana, screw type and hardware.			35	152346	51-5701G4	1001	2	2		4		8	P401A
P402	PPI input plug assembly	Plug panel assembly			28		3C1-321	1002	2	1		1		2	P402
P402A		Plug, banana, rivet type and hardware.			35	152015	51-5803G1	1003	2	2		4		8	P402A
		RESISTORS													
R401	V401A grid resistor	Resistor, composition, 25,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5225	1008	2	1		2		3	R401
R402	V401A grid resistor	Resistor, composition, 75,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5233	1009	2	1		2		3	R402

Revised 3-21-44

0 No spares furnished
- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd)													
R403	V401A grid resistor	Resistor, composition, 390,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5474	1010	2	1		2		3	R403
R404	V401A plate resistor	Resistor, composition, 22,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5224	1011	2	1		2		3	R404, R405, R406, R407, R408, R409
R405	V401A plate resistor	Same as R404	-63291							-		-		-	
R406	V401A plate resistor	Same as R404	-63291							-		-		-	
R407	V401A plate resistor	Same as R404	-63291							-		-		-	
R408	V401A plate resistor	Same as R404	-63291							-		-		-	
R409	V401A plate resistor	Same as R404	-63291							-		-		-	
R410	V401B plate resistor	Resistor, composition, 30,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5229	1015	2	1		2		3	R410, R411
R411	V401B plate resistor	Same as R410	-63291							-		-		-	
R412	V401B grid resistor	Resistor, composition, 50,000 Ω ± 5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5262	1017	2	1		2		3	R412
R413	V402A plate resistor	Resistor, composition, 50,000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5230	1018	2	1		2		3	R413, R458
R415	V402A grid resistor	Resistor, composition, 500,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5243	1019	2	1		2		3	R415, R451
R416	V402A plate resistor	Resistor, composition, 500,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 372J	34	CM-1	80-5241	1020	2	1		2		3	R416
R417	Sweep shaping resistor	Resistor, composition, 15,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5300	1021	2	1		2		3	R417
R418	Sweep shaping resistor	Resistor, composition, 2000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5212	1022	2	1		2		3	R418
R419	Sweep centering resistor	Resistor, composition, 100 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5203	1023	2	1		2		3	R419
R420	Sweep centering resistor	Resistor, composition, 1500 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5328	1024	2	1		2		3	R420, R495
R421	Sweep centering control	Resistor, potentiometer, wirewound, 3000 Ω ±10%, 25 watts, linear taper, special shaft.		RE 13A 492C	8	PW-25-3000	40-5033	1025	2	1		3		5	R421
R422	V403 cathode resistor	Resistor, wirewound, 500 Ω ±5%, Style E, Grade 1, Class II.	-63278-E	RE 13A 372J Style E	20	GT-5-C	80-5014	1026	2	1		2		3	R422
R423	Sweep length control	Resistor, potentiometer, wirewound, 500 Ω ±10%, 25 watts, linear taper, spec. shaft.		RE 13A 492C	20	PW-25-500	40-5032P1	1027	2	1		3		5	R423
R424	Sweep damping resistor	Resistor, composition, 15,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5220	1028	2	1		2		3	R424
R425	Voltage divider resistor	Resistor, wirewound, 500 Ω ±5%, Style D, Grade 1, Class II.	-63070-E	RE 13A 372J Style D	18		80-5250	1029	2	1		2		3	R425
R426	Voltage divider resistor	Resistor, composition, 30,000 Ω ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5228	1030	2	1		2		3	R426, R427, R428
R427	Voltage divider resistor	Same as R426	-63288							-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R428	Voltage divider resistor	Same as R426	-63288							-		-		-	
R429	V401B bias control	Resistor, potentiometer, 10,000 Ω ±10%, 3 watts, linear taper spec. shaft.		RE 13A 492C	8	P58-W	40-5023P2	1032	2	1		3		5	R429
R430	Voltage divider resistor	Resistor, composition, 25,000 Ω ±10%, 1 watt, pigtail terminals.	-63288		34	CM-1	80-5227	1033	2	1		2		3	R430
R431	Voltage divider resistor	Resistor, composition, 5000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5216	1034	2	1		2		3	R431, R432, R433, R434, R435, R436
R432	Voltage divider resistor	Same as R431	-63288							-		-		-	
R433	Voltage divider resistor	Same as R431	-63288							-		-		-	
R434	Voltage divider resistor	Same as R431	-63288							-		-		-	
R435	Voltage divider resistor	Same as R431	-63288							-		-		-	
R436	Voltage divider resistor	Same as R431	-63288							-		-		-	
R437	Voltage divider resistor	Resistor, wirewound, 300 Ω ±5%, Style D, Grade 1, Class II.	-63065-E	RE 13A 372J Style D	18		80-5249	1037	2	1		2		3	R437
R438	Voltage divider resistor	Resistor, composition, 20,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5223	1038	2	1		2		3	R438
R439	Trigger line terminating resistor	Resistor, composition, 68 Ω ±10%, ½ watt.	-63360	RE 13A 372J	34	MB-½	80-5259	1039	2	1		2		3	R439
R440	Voltage divider resistor	Resistor, wirewound, 10,000 Ω ±5%, Style D, Grade 1, Class II.	-63090-E	RE 13A 372J	18		80-5031	1040	2	1		2		3	R440
R441	PPI dial lights control	Resistor, potentiometer, wirewound, 15 Ω ±10%, 25 watts, linear taper, special shaft.		RE 13A 492C	8	PW-25-15	40-5028P1	1041	2	1		3		5	R441
R442	V402B grid resistor	Resistor, composition, 500,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5242	1042	2	1		2		3	R442
R443	V402B plate resistor	Resistor, composition, 100,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5234	1043	2	1		2		3	R443, R444, R445, R446
R444	V402B plate resistor	Same as R443	-63288							-		-		-	
R445	V402 plate resistor	Same as R443	-63288							-		-		-	
R446	V402B plate resistor	Same as R443	-63288							-		-		-	
R447	V404A grid resistor	Resistor, composition, 25,000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5226	1045	2	1		2		3	R447, R463
R448	V404A plate resistor	Resistor, composition, .25 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5238	1046	2	1		2		3	R448
R449	V404B grid resistor	Resistor, composition, 100,000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5235	1047	2	1		2		3	R449, R484, R486, R490, R492
R450	V404B plate resistor	Resistor, composition, 15,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5222	1048	2	1		2		3	R450, R465, R466, R467
R451	V401A grid resistor	Same as R415	-63360							-		-		-	
R452	V405A plate resistor	Resistor, composition, 5000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5215	1049	2	1		2		3	R452

- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd)													
R453	V405B plate resistor	Resistor, composition, 12,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5256	1050	2	1		2		3	R453
R455	Range mark amplitude control	Resistor, potentiometer, 10,000 Ω ±5%, 2.5 watts, linear taper, spec. shaft.		RE 13A 492C	81	WI-10M	40-5004P6	1051	2	1		3		5	R455
R456	V405B grid resistor	Resistor, composition, 1 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5244	1052	2	1		2		3	R456
R457	V407 cathode resistor	Resistor, composition, 1000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5293	1053		1		2		3	R457
R458	Intensity limiting resistor	Same as R413	-63360									-		-	
R459	Intensity limiting resistor	Resistor, potentiometer, wirewound, 15,000 Ω ±10%, 4 watts, linear taper, special shaft.		RE 13A 492C	8	P10-W	40-5025P1	1055	2	1		3		5	R459, R468
R460	V403 plate resistor	Resistor, composition, 50 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5260	1056	2	1		2		3	R460
R462	V406A cathode resistor	Resistor, composition, 100 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5204	1057	2	1		2		3	R462, R483
R463	Relative bearing flasher filter resistor	Same as R447	-63360							-		-		-	
R464	Relative bearing flasher voltage divider	Resistor, composition, 10,000 Ω ±10%, ½ watt, pigtail terminals.	-63360		34	MB-½	80-5218	1059	2	1		2		3	R464, R489, R491
R465	Focus current limiting resistor	Same as R450	-63288							-		-		-	
R466	Focus current limiting resistor	Same as R450	-63288							-		-		-	
R467	Focus current limiting resistor	Same as R450	-63288							-		-		-	
R468	Focus control	Same as R459								-		-		-	
R470	High voltage bleeder resistor	Resistor, composition, 500,000 Ω ±10%, 1 watt.	-63288	RE 13A 372J	34	CM-1	80-5240	1061	2	1		2		3	R470, R471, R472, R473, R474, R475, R476, R477, R478, R479, R480
R471	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R472	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R473	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R474	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R475	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R476	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R477	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R478	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R479	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R480	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R481	High voltage filter resistor	Resistor, composition, 250,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5237	1065	2	1		2		3	R481, R482

Revised 3-21-44

- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd)													
R482	High voltage filter resistor	Same as R481	-63288							-		-		-	
R483	Video line terminating resistor	Same as R462	-63360							-		-		-	
R484	V406A grid resistor	Same as R449	-63360							-		-		-	
R485	V406A plate resistor	Resistor, composition, 2500 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5213	1067	2	1		2		3	R485
R486	V406B grid resistor	Same as R449	-63360							-		-		-	
R487	V406B plate resistor	Resistor, composition, 3000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5214	1069	2	1		2		3	R487
R488	IFF line terminating resistor	Resistor, composition, 50 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 372J	34	MB-½	80-5200	1070	2	1		2		3	R488
R489	Voltage divider resistor	Same as R464	-63355							-		-		-	
R490	Voltage divider resistor	Same as R449	-63360							-		-		-	
R491	Voltage divider resistor	Same as R464	-63355							-		-		-	
R492	Voltage divider resistor	Same as R449	-63360							-		-		-	
R493	Relative bearing flasher voltage divider	Resistor, composition, 2000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 372J	34	MB-½	80-5211	1072	2	1		2		3	R493, R499
R494A B	Tune set control	Resistor, dual potentiometer, wirewound, each section, 20,000 Ω ±10%, 3 watts, linear taper, special shaft.		RE 13A 492C	8	DP-58W	40-5026	1073	2	1		3		5	R494
R495	Sweep centering resistor	Same as R420	-63355							-		-		-	
R496	Receiver tune limiting resistor	Resistor, composition, 50,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 372J	34	CM-1	80-5231	1075	2	1		2		3	R496
R497	Receiver tune control	Resistor, potentiometer, 100,000 Ω ±10%, 2 watts, linear taper, special shaft.		RE 13A 492C	34	Type "C"	40-5027	1076	2	1		3		5	R497
R498	Receiver gain control	Resistor, potentiometer, wirewound, 10,000 Ω ±10%, 50 w left hand taper, 2000 Ω at 50% rotation, spec. shaft.		RE 13A 492C	8		40-5024	1077	2	1		3		5	R498
R499	Voltage divider resistor	Same as R493	-63360							-		-		-	
		SWITCHES													
S401	Range switch	Switch, rotary, 4 ceramic wafers, silvered wiping contacts, shorting type rotor blades as follows:			26	Type "H"	28-5069G1	1085	2	1		1		1	S401
S401E		First wafer--One single pole, circuit opens in third position. S401 - Standard Arrangement.													
S401D F		Second wafer--Two single pole, three circuit groups. S401D - Standard Arrangement S401F - Special arrangement open in 3rd position.													
S401B		Third wafer--One single pole, 3 circuit contact groups and 3 resistor support lugs. S401B - Standard arrangement.													

Revised 3-21-44

- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-55ADO PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		SWITCHES (Cont'd)													
S401A C		Fourth wafer--Two single pole, three circuit contact groups. S401A - Standard arrangement. S401C - Special arrangement.													
S402	Motor switch	Switch, lever type, DPDT, 1 break per circuit, current rated for 10 amps, @ 110 v ac.			36		28-5071P1	1086	2	1		1		1	S402
S403	Main switch	Switch, toggle type, DPST, current rated for 3 amps, @ 115 v dc.			4	8947-BE	28-5074	1087	2	1		1		1	S403
S404	Normal emergency switch	Switch, dual toggle type SPDT, front unit to "make" before rear unit "breaks", front unit 3 a @ 115 v dc. Rear unit 1 amp. @ 115 v dc.			4	21490-BK	28-5075	1088		1		1		1	S404
S405	Modulation switch	Switch, push button type, 1 contact normally open, 1 contact normally closed, wiping contacts rated 1 a @ 115 v dc with red & black push buttons.			28		28-5070P2	1089	2	1		1		1	S405
S408	Synchronizing switch	Switch, roller leaf, super sensitive, SPST norm. open rated 10 a, 115 v ac.			25	4-MZGW-21	28-5068	1091	2	1		1		1	S408
		TRANSFORMERS													
T401	Low voltage power transformer	Transformer, Plate: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps. / Test V r.m.s. Pri. 208 24E 2.6 115 .48 1780 Sec.#1 1150 29E 60 600 .175 1780 Pri. rated: 55 va (approx.) Elec. shield. Sec. CT. Wt. 1 lb., 8 oz.		RE 13A 554D	28	UX-8301C	92-340G1	1096	2	1		2		3	T401
T402	General filament transformer	Transformer, Filament: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps. / Test V r.m.s. Pri.#1 600 27E 9 115 .46 1780 Pri.#2 600 27E 9 115 .46 1780 Sec.#1 35 14E .039 6.3 4.7 1780 Sec.#2 28 16E .047 5.0 3.0 1780 Sec.#3 35 23E .30 6.3 0.6 1780 Pri. rated: 52.8 va (approx.) Elec. shield. Wt. 1 lb., 9 oz.		RE 13A 554D	28	UX-8302C	92-341G1	1097	2	1		2		3	T402
T403	High voltage transformer	Transformer, Plate and Filament: Pri. 115/400/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps. / Test V r.m.s. Pri. 288 26E 4.5 115 0.23 1780 Sec.#1 11,650 41HE 6800 4580 .002 11kv Sec.#2 7 16SCE .019 2.5 5 11kv Pri. rated: 26.4 va (approx.) Elec. shield. Wt. 4 lbs., 14 oz.		RE 13A 554D	28	UX-7732A	92-387G1	1098	2	1		2		3	T403

Revised 3-21-44

- For spares see reference given in "Description column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
* VACUUM AND GASEOUS DISCHARGE TUBES															
V401A B	Multivibrator tube Multivibrator tube	Twin triode low MU amplifier.	6SN7-GT		29	6SN7-GT	90-5051			2		3		0	V401, V402, V404, V405, V406
V402A B	Sweep generator tube Marker oscillator tube	Same as V401	6SN7-GT							-		-		-	
V403	Magnetic sweep tube	Transmitting beam power amplifier.	807		29	807	90-5039			2		3		0	V403
V404A B	Range mark shaping tube Range mark shaping tube	Same as V401	6SN7-GT							-		-		-	
V405A B	Range mark shaping tube Range mark shaping tube	Same as V401	6SN7-GT							-		-		-	
V406A B	Video amplifier tube Video amplifier tube	Same as V401	6SN7-GT							-		-		-	
V407	Plan Position Indicator tube	5" magnetic deflection, long persistance CR tube.			15	5FP7	90-5076			3		6		0	V407
V408	Low voltage rectifier tube	Full wave rectifier.	5U4-G		29	5U4-G	90-5056			2		3		0	V408
V409	High voltage rectifier tube	Half wave, high vacuum rectifier.			28	RKR-72	90-5073			3		6		0	V409
SOCKETS AND FUSE HOLDERS															
X401	Socket for V401	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts.			2	SS-8M	82-5012P2	1110	2	1		1		1	X401, X402, X404, X405, X406, X407, X408
X402	Socket for V402	Same as X401								-		-		-	
X403	Socket for V403	Vacuum tube socket, 5 contacts, ceramic wafer, silvered contacts.			2	SS-5M	82-5017P1	1112	2	1		1		1	X403
X404	Socket for V404	Same as X401								-		-		-	
X405	Socket for V405	Same as X401								-		-		-	
X406	Socket for V406	Same as X401								-		-		-	
X407	Socket for V407	Same as X401								-		-		-	
X408	Socket for V408	Same as X401								-		-		-	
X409	Socket for V409	Vacuum tube socket, 4 contacts, ceramic wafer, silvered contacts.			2	SS-4M	82-5016P1	1114	2	1		1		1	X409
X410	Socket for I401	Socket, pilot lamp, bayonet type.			3	1787	81-5034	1115	2	1		1		1	X410, X411, X412, X413
X411	Socket for I402	Same as X410								-		-		-	
X412	Socket for I403	Same as X410								-		-		-	
X413	Socket for I404	Same as X410								-		-		-	
SPECIAL TUNED CIRCUIT ASSEMBLIES															
TC401	One mile marker oscillator	Inductor, lc. Tuned to 81.96 KC adj. iron core.			31	12527	92-5084	1126	2	1		1		1	TC401
TC402	Four mile marker oscillator	Inductor, lc. Tuned to 16.4 KC adj-iron core.			31	12716	92-5092	1127	2	1		1		1	TC402
TC403	Fifteen mile marker oscillator	Inductor, lc. Tuned to 4.1 KC adj. iron core.			31	12715	92-5093	1128	2	1		1		1	TC403

0 No spares furnished
* Packed in wood boxes - see Packing List
- For spares see reference given in "Description" column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES													
		Tube clip					3C8-190P1	1133		0		0		1	
		Tube shock ring (PPI)					3C1-24P1	1134	2	1		1		2	
		Tube pad (PPI)					3C1-23P1	1135	2	1		1		2	
		Grid clips					27-5124P2	1136		0		0		1	
		Grid clips					27-5024P2	1137		0		0		1	
		Window assembly					3C25-125P1	1138		0		1		2	
		Window gasket					3C7-298P1	1139	2	1		2		4	
		Window seal ring			28		3C7-301P1	1140		0		1		1	
		Dial drive assembly			28		3C14-141P1	1144		0		1		2	
		Driver dial assembly					3C46-363	1145		0		1		2	
		Dial assembly			28		3C27-233	1146		0		1		2	
		Cable assembly for V407 anode connection			62		51-5699G1	1147	2	1		1		2	
		Resistor panel assembly			28		3C13-138	1148	2	1		2		3	
		Motor coupling			66	J-1211-2	3C1-351	1149		0		1		1	
		Lever bar assembly			28		3C5-258	1150		0		1		2	
		Rubber diaphragm					3C7-299P1	1151	2	1		2		4	
		Captive screw					3C1-25P1	1152		0		2		2	
		Captive screw					3C1-25P2	1153		0		2		2	
		Gasket					3C7-354P1	1154	2	1		2		4	
		Gasket					3C7-239P4	1155	2	1		2		4	
		Gasket					3C7-126P1	1156	2	1		2		4	
		Gasket					3C7-189P1	1157	2	1		2		4	
		Gasket (PPI)					3C1-72P1	1158	2	1		2		4	
		Gasket					3C7-239P1	1159	2	1		2		4	
		Gasket					3C7-239P2	1160	2	1		2		4	
		Gasket					3C5-144P1	1161	2	1		2		4	
		Gasket					3C5-145P1	1162	2	1		2		4	
		Captive screw					3C7-382	1163		0		2		2	
		Captive nut					3C6-118	1164		0		2		2	
		Rubber gauntlet					3C7-220P1	1165	2	1		2		4	

0 No spares furnished

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55ADQ PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		MECHANICAL SPARES (Cont'd)													
		Lever bar handle			28		3C5-260	1166		0		1		1	
		Shock mount			91		3C28-256P2	1167	2	1		1		2	
		Shaft lock					31-5013P2	1168		0		1		1	
		Slider foot					3C6-124P1	1169		0		0		2	
		Lever hook block assembly					3C8-180	1170		0		1		2	
		Air valve assembly					3C18-194	1171		0		1		2	
		Knob (large)					3C23-103	1172	2	1		2		3	
		Hand crank assembly					3C22-208	1173		0		1		2	
		Handle motor switch					3C7-218P1	1174		0		1		1	
		Plug, threaded					3C5-186P2	1175		0		1		1	
		Potentiometer waterproof assembly					3C41-344	1176		0		1		2	
		Knob (small)					3C24-102	1177		0		1		2	
		Red moulded plastic push button marked "stop" with inserts, screws & lockwashers.					3C7-340P1	1178		0		1		1	
		Black moulded plastic push button marked "start" with inserts, screws & lockwashers.					3C7-340P2	1179		0		1		1	
		Grommet					4-5024	1180	2	1		2		4	
		Grommet					4-5025	1181	2	1		2		4	
		Grommet					4-5026P1	1182	2	1		2		4	
		Gasket					3C7-354P2	1183	2	1		2		4	

0 No spares furnished

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-66AGE ANTENNA ASSEMBLY

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
NAVY TYPE CRP-66 --- ANTENNA ASSEMBLY															
		Antenna assembly	-66AGE		28	WX-4763		1201		0		0		2	
MOTORS AND SYNCHRO UNITS															
B501		Motor synchro, 400~, 90-115 v.			14	Type 5SF	115-5021	1205		*		*		*	B501 For spares see B401 Page 4
B503	Rotate antenna	Motor, antenna drive 115 v dc 1/8 HP, 1725 rpm.			87	D61220	115-5050G2	1206	3	1		2		3	B503
B503C		Set (2) brush holder assemblies.			87		103-5031	1207	3	1		4		6	B503C
B503D		Set (2) brush and spring assemblies.			87		103-5030	1208	3	5		10		20	B503D
CAPACITORS															
C501	Prevent arcing at thermostat points	Capacitor, paper, 0.1 mfd., ±10%, 600 v dc wkg.	-48197-A10	RE 48A 129 RE 13A 488D	33	2528-1	35-5049	1215	3	1		2		3	C501
TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS															
E506	Interconnecting cable terminal strip	Terminal strip, bakelite barrier type, 10 solder terminals with 6-32 x ¼" binder head screws.			21	10-141-¾W	47-5029P3	1220		0		0		1	E506, E507, E508
E507	Interconnecting cable terminal strip	Same as E506								-		-		-	
E508	Interconnecting cable terminal strip	Same as E506								-		-		-	
E509	Torque motor junction terminal strip	Terminal strip, bakelite barrier type, 12 solder terminals with 6-32 x ¼" binder head screws.			21	12-141-¾W	47-5048P3	1223		0		0		1	E509
RECEPTACLES															
J501	Phone connection	Phone jack			28		76-5004	1225		*		*		*	J501 For spares see S506

0 No spares furnished
- For spares see reference given in description column
* For spares see reference given in "All Symbol Designations" column.

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-66AGE ANTENNA ASSEMBLY

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		PLUGS AND PROBES													
P501	Connector to resonance chamber waveguide pickup	Connector, singe shielded conductor	-49268		28		6-5174G1	1230	3	1		1		2	P501
P501A		Gasket for plug					105-5650	1231	3	1		2		4	P501A
		RESISTORS													
R503	Heater for antenna pedestal case	Resistor, fixed resistance strip, wirewound, 44 Ω 300W, 115V, 3 heat					80-5357	1235	3	1		3		5	R503
		SWITCHES, INTERLOCKS AND THERMOSTATS													
S501	Synchronizing switch	Switch, SPDT roller leaf contacts, rated 10 a, 115 v dc.			25	4-MBZW-21	28-5067	1240	3	1		1		1	S501, S504, S505
S502	Thermostat	Thermostatic switch cartridge type, opens at 23° C, 115 v ac			13	4-732RC	28-5073P2	1241	3	1		2		4	S502
S504	Synchronizing switch	Same as S501								-		-		-	
S505	Synchronizing switch	Same as S501								-		-		-	
S506		Circuit switch and phone jack assembly			28		51-5878	1244	3	1		1		1	S506
		SPECIAL R.F. ASSEMBLIES													
RF501		Lower waveguide assembly			28		14A5-100			0		0		0	RF501
RF502		R.F. nozzle assembly			28		14A4-61			0		0		0	RF502
RF503		Reflector assembly			28		14A3-98			0		0		0	RF503
RF513		Waveguide coupling assembly			28		12A1-107			0		0		0	RF513
RF514		Reflector			28		12A1-61			0		0		0	RF514
		Waveguide (10' length)			28		110T-5000	1255		0	*	3	*	6	
RF515		Waveguide resonance chamber assembly			28		4J10-34	1256		0	*	1		2	RF515
		Gasket for waveguide flange			28		87-5009P1	1257	3	1		2		4	

0 No spares furnished
- For spares see reference given in description column
* Packed in wood box

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-66AGE ANTENNA ASSEMBLY

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		MECHANICAL SPARES													
		Differential assembly					14A7-372	1265		0		1		1	
		Screw					14A3-121	1266		0		2		4	
		Screw					14A3-122	1267		0		2		4	
		Screw					14A1-210	1268		0		2		4	
		Screw					14A1-213	1269		0		2		4	
		Screw					14A1-214	1270		0		2		4	
		Screw					14A1-34	1275		0		2		4	
		Screw					14A1-134	1276		0		2		4	
		Cap screw					14A1-238	1277		0		2		4	
		Thumb screw					9-5118P9	1278		0		2		4	
		Shoulder screw					14A2-157	1279		0		2		4	
		Captive screw					14A2-192	1281		0		2		4	
		Key					14A2-58	1282	3	1		1		2	
		Key					14A2-63	1283	3	1		1		2	
		Shim					14A1-209	1284		0		1		3	
		Shim					14A1-48	1290		0		1		3	
		Gasket					12A1-160	1291	3	1		2		4	
		Gasket					14A2-33	1292	3	1		2		4	
		Gasket					14A2-164	1293	3	1		2		4	
		Gasket					14A1-41	1294	3	1		2		4	
		Gasket					14A1-67	1295	3	1		2		4	
		Gasket					14A1-66	1296	3	1		2		4	
		Gasket					14A1-31	1297	3	1		2		4	
		Gasket					14A1-165	1298	3	1		2		4	
		Gasket					14A1-166	1299	3	1		2		4	
		Gasket					14A1-167	1301	3	1		2		4	
		Gasket					14A1-168	1302	3	1		2		4	
		Gasket					14A1-169	1305	3	1		2		4	

0 No spares furnished

Revised 3-21-44

CONFIDENTIAL

TABLE II

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-66 --- ANTENNA ASSEMBLY

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		MECHANICAL SPARES (Cont'd)													
		Gasket					14A10-259	1306	3	1		2		4	
		Gasket					14A10-287	1307	3	1		2		4	
		Gasket					14A4-59	1308	3	1		2		4	
		Gear					14A2-159	1309		0		1		1	
		Ring gear					14A2-142	1315		0		1		1	
		Pinion gear					14A2-103	1316		0		1		1	
		Coupling					14A2-69	1317		0		1		1	
		Oil seal					87-5055P2	1318		0		1		1	
		Bearing			93	XLS3½F	102-5120	1319	3	1		1		1	
		Bearing			93	XLS3F	102-5119	1320	3	1		1		1	
		Lucite					14A4-145	1321	3	1		2		4	
		Gear reduction unit					14A2-94	1322		0		1		1	

0 No spares furnished

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CRP-14AAN RESONANCE CHAMBER

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-14AAN RESONANCE CHAMBER													
		Resonance Chamber	-14AAN		28	WX-4806	3E-1	1401		0		0		1	
		DIAL AND PILOTS LIGHTS													
I601	Phantom target tuning indicator	Indicator neon bulb assembly.			28		3E3-24	1405	3	2		4		6	I601
		PLUGS AND PROBES													
P601	Plug for resonance chamber antenna	RMA UHF Coaxial connector.			28		105-5201G2	1451	3	1		1		2	P601
		MECHANICAL SPARES													
		Washer, bulb, 9/16" dia. x 1/16" thick.					3E3-52P1	1470		0		1		1	
		Washer, 11/16" O.D. x ½" I.D. x 1/16" thick.					3E2-38P1	1471		0		1		1	
		Bushing, centering, phenolite 21/64" dia. x 25/64" long.					3E2-23	1472	3	1		1		2	
		Spacer, 2-3/8" O.D. x 1-5/8" I.D. x 1/16" thick.					3E-63P1	1473		0		1		1	

Revised 3-21-44

0 No spares furnished

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
CRP-23ADD IFF CONTROL UNIT WX-5641

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		CRP-23ADD IFF CONTROL UNIT													
		IFF Control Unit	-23ADD		28	WX-5641	30A1-1	2601		0		0		1	
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E1201	IFF and line voltage terminal strip	Terminal strip, bakelite barrier type, 10 solder terminals with 6-32 x ¼" binder head screws.			21	10-141-¼W	47-5029P3	2611		0		0		1	E1201, E1202
E1202	IFF and line voltage terminal strip	Same as E1201								-		-		-	
		FUSES													
F1201	Line fuse	Fuse 3 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25003	26-5037	2616		10		20		50	F1201
		METERS													
M1201	Meter, resonance indicator output and line voltage	Voltmeter, ac, 300 to 600 ~ frequency, 0-150 v scale.			28		45-5013	2621		0		0		1	M1201
		SWITCHES													
S1201	IFF switch	Switch, lever type, 4PDT, 3 position, center open.			36		28-5079P2	2626		1		1		1	S1201
		MISCELLANEOUS PARTS													
		Captive screw					9-5051	2631		0		2		2	
		Shock mount					39-5011	2632		1		1		2	
		Gasket					30A1-29	2633		1		2		4	

0 No spares furnished
- For spares see reference given in "Description" column

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-62108 JUNCTION BOX

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-62108 JUNCTION BOX													
		Junction box	-62108		28	WX-5642	4E1-100	2801		0		0		1	
		CAPACITORS													
C1301	K1301 and K1302 contact by-pass capacitor	Capacitor, paper, 4 mfd., ±10%, 1000 v dc wkg.	-481050-10		9	TJU-10040	35-5063	2805	3	1		2		3	C1301
C1302	K1301 and K1302 contact by-pass capacitor	Capacitor, paper, 2 mfd., ±10%, 1000 v dc wkg.	-481049		9	TJU-10020	35-5080	2806	3	1		2		3	C1302, C1303
C1303	K1301 and K1302 contact by-pass capacitor	Same as C1302	-481049							-		-		-	
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E1306	Junction for heater and motor power from modulator	Terminal strip, bakelite barrier type, 2 solder terminals with 8-32 x 5/16" binder head screws			21	2-142-¾W	47-5014P3	2815		0		0		1	E1306
E1307	Junction for antenna, indicator and IFF control unit	Terminal strip, bakelite barrier type, 10 solder terminals with 6-32 x ¼" binder head screws			21	10-141-¾W	47-5029P3	2816		0		0		1	E1307, E1308

0 No spares furnished
- For spares see reference given in description column

Revised 3-21_44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-62108 JUNCTION BOX

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS (Cont'd)													
E1308	Junction for antenna, indicator and IFF control unit	Same as E1307								-		-		-	
E1309	Junction for antenna, indicator and IFF control unit	Terminal strip, bakelite barrier type, 12 solder terminals with 6-32 x ¼" binder head screws			21	12-141-¾W	47-5048P3	2818		0		0		1	E1309
E1310	Junction for antenna, indicator and IFF control unit	Terminal strip, bakelite barrier type, 8 solder terminals with 6-32 x ¼" binder head screws			21	8-141-¾W	47-5021P3	2819		0		0		1	E1310
		CONTACTORS AND RELAYS													
K1301	Antenna armature current control	Relay 4 PDT, 24 v dc coil contacts rated 15a			75	BO-12D35	71-5023	2830	3	1		2		3	K1301, K1302
K1302	Antenna armature current control	Same as K1301								-		-		-	
		RESISTORS													
R1301	Antenna motor armature resistor	Resistor, fixed resistance strip, wirewound, 5 Ω, 7a, 250 watts monel sheath with mounting feet			90	S920	80-5326	2840	3	1		3		5	R1301, R1302, R1303
R1302	Antenna motor armature resistor	Same as R1301								-		-		-	
R1303	Antenna motor armature	Same as R1301								-		-		-	
R1304	Relay dropping resistor	Resistor, wirewound, 800 Ω, ±5%, style E, Grade I, Class 1	-63984-F		33		80-5267	2843	3	1		2		3	R1304, R1305
R1305	Relay dropping resistor	Same as R1304	-63984-F							-		-		-	

0 No spares furnished
- For spares see reference given in description column

Revised 3-21-44

CONFIDENTIAL

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY TYPE CDD-211045 MAGNETIC CONTROLLER AND NAVY TYPE CBZ-24216 STOP-START SWITCH

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
NAVY TYPE CDD-211045 MAGNETIC CONTROLLER															
		Magnetic Controller	-211045		42		91-5084	5401		0		0		1	
K112	Overload relay assembly	Overload relay assembly.					4J-21	5405	3	1		2		3	K112
K113	Operating coil	Operating coil.			42	CRY59	4J-19	5406	3	1		3		3	K113
K113A		Set (8) contacts.			42		4J-26	5407	3	1		2		2	K113A
K113B		Set (4) intermediate fingers.			42		4J-25	5408	3	1		2		2	K113B
K113C		Set (5) springs.			42		4J-22	5409	3	1		1		1	K113C
K114	Accelerating coil	Accelerating coil.			42	CRY188	4J-20	5410	3	1		3		3	K114
K114A		Set (2) contacts.			42		4J-24	5411	3	1		2		3	K114A
K114B		Spring (2 per set).			42		4J-23	5412	3	1		2		3	K114B
NAVY TYPE CBZ-24216 STOP-START SWITCH															
		Stop-Start Switch	-24216		1		28-5091P2			0		0		1	

Revised 3-21-44

0 No spares furnished

CONFIDENTIAL

TABLE II
MISCELLANEOUS SPARE PARTS
FOR MODEL SO-1 RADAR EQUIPMENT WX-4821A

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		TOOLS													
		Spanner wrench, for V311 tip.					118-5238	6000	3	1		1		2	
		Collet tip wrench, for V311 tip.					118-5237	6001	3	1		1		2	
		Pliers, for V311 tip.					118-5236	6002	3	1		1		2	
		Setting gauge for V311 tip.					118-5181	6003	3	1		1		2	
		Special wrench for indicator front panel.					118-5230	6004	3	1		1		2	
		Wrench for cavity tuning plug.					118-5173G1	6005	3	1		1		2	
		Wrench, Allen #4.					118-5191	6006	3	1		1		2	
		Wrench, Allen #6.					118-5175	6007	3	1		1		2	
		Wrench, Allen #8.					118-5168	6008	3	1		1		2	
		Wrench, Allen #10.					118-5169	6009	3	1		1		2	
		Wrench, Allen ¼".					118-5179	6010	3	1		1		2	
		Wrench, Allen, 5/16".					118-5217	6011	3	1		1		2	
		Wrench, Allen.					4D10-200	6012	3	1		1		2	
	For removing shipping plugs.	Screwdriver					118-5187	6013	3	1		1		2	
	For pulse cable stuffing tube	Pulse line spanner wrench.					118-5190	6014	3	1		1		2	
		T. R. F. wrench					118-5227	6015	3	1		1		2	
	Used on Indicator	Open end offset wrench 1".					118-5231	6016	3	1		1		2	
		Water pump pliers 10".					118-5188	6017	3	1		1		2	
		Indicator test cable.			28		3C-326	6018	3	1		1		2	
		Indicator test cable.			28		3C-327	6019	3	1		1		2	
		SPECIAL CABLES AND MISCELLANEOUS WIRE													
		Receiver Power cable, six-conductor cable shielded.			52	CO-137	73-5049	6101	3	2'		6'		20'	
		Coaxial cable (small) single conductor, shielded.			60	8664	73-5000P2	6102	3	5'		50'		100'	
		#14 wire, tinned bus.			80		73-5055	6103	3	5'		10'		20'	
		#20 wire, tinned bus.			80		73-5015	6104	3	5'		10'		20'	
		#14 wire, aircraft type - green			73		73-5057	6105	3	5'		50'		100'	
		#14 wire, aircraft type - brown, green tracer			73		73-5006	6106	3	5'		50'		100'	
		#18 wire, aircraft type - red.			73		73-5003	6107	3	5'		50'		100'	

CONFIDENTIAL

TABLE II
MISCELLANEOUS SPARE PARTS
FOR MODEL SO-1 RADAR EQUIPMENT WX-4821A

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		SPECIAL CABLES AND MISCELLANEOUS WIRE (Cont'd)													
		#18 wire, aircraft type - green.			73		73-5004	6108	3	5'		50'		100'	
		#18 wire, aircraft type - blue.			73		73-5039	6109	3	5'		50'		100'	
		#18 wire, aircraft type - brown, red tracer.			73		73-5001	6110	3	5'		50'		100'	
		#18 wire, aircraft type - brown, green tracer.			73		73-5002	6111	3	5'		50'		100'	
		#18 wire, aircraft type - red, 5000 v insulated.			73		73-5021	6112	3	5'		50'		100'	
		MISCELLANEOUS PARTS & HARDWARE													
	Used on Trans.-Rcvr., Indicator and Accessory Control Unit	Dehydrator plug package.			51		79-5033G1	6201	3	10		60		100	
		Resistor clip	-28004				26-5010P1	6202	3	1		1		1	
		Fuse clip	-28002				26-5008P1	6203	3	1		1		1	
		Fuse clip	-28003				26-5009P1	6204	3	1		1		1	
		Fuse clip					26-5011	6205	3	1		1		1	
		Gasket - waveguide flange.					87-5009P1	6208	3	1		2		4	
		Waveguide (10' lengths).					110T-5000	6209		0		3		6	
		Tube clamps.					88-5009P1	6210	3	1		1		1	
		Screw, flat hd. SS machine cut, 4-40NC2 x ¾".					9-5099	6211		0		1		1	
		Nut, 6-32 spec., ¼" hex. cad. plated.					3-5069P2	6212		0		1		1	
		Nut, 3/8-32 SS.					3-5024	6213		0		1		1	
		Nut, knurled 8-32 thd., 3/8" dia., brass-nickel plated.					3B13-93P1	6214		0		1		1	
		Nut, ¼-20 thd., ¾" hex. SS.					3C28-253P1	6215		0		1		1	
		Nut, 9/16-18 NF-2 thd., ¾" hex. brass nickel plated.					3C7-106P1	6216		0		1		1	
		Washer, #4 fibre.					36-4-6FO	6217	3	1		2		4	
		Washer, #6 cork.					36-6-1E	6218	3	1		2		4	
		Washer, #6 fibre.					36-5017	6219	3	1		2		4	
		Washer, #10 cork.					36-10-1E	6220	3	1		2		4	
		Lockwasher SS, 7/8" O.D. x 9/16" I.D. x 1/16" thick.					3C7-168P1	6221		0		1		1	
		Lockwasher SS, 1-3/16" O.D. x 7/8" I.D. x 1/16" thick.					3C7-168P2	6222		0		1		1	

0 No spares furnished

CONFIDENTIAL

TABLE II
MISCELLANEOUS SPARE PARTS
FOR MODEL SO-1 RADAR EQUIPMENT WX-4821A

PART									SPARES						
									EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MISCELLANEOUS PARTS & HARDWARE (Cont'd)													
		Washer, SS, 1 ¾" O.D. x .404" I.D. x 1/8" thick.					3B43-306	6223		0		1		1	
		Washer, brass nickel plated, 5/8" O.D. x 3/16" I.D. x 1/32" thick.					3C1-20	6224		0		1		1	
		Washer, spacing, C.R.S., cad. plated, 1 7/16" O.D. x 1 11/64" I.D. x .025" thick.					3B19-315	6225		0		1		1	
		Washer, aluminum, .359" O.D. x 1/8" I.D. x 1/16" thick.					3C22-214	6226		0		1		1	
		Washer, micalex, 2 ¾" O.D. x 1/16" thick.					36-5056	6227	3	1		2		4	
		Washer, cork 3/8" O.D. x 1/8" I.D. x 1/64" thick.					36-5084	6228	3	1		2		4	
		Washer, cork, ¾" O.D. x 3/16" I.D. x 1/64" thick.					36-5094	6229	3	1		2		4	
		Washer, rubber 1 7/8" O.D. x 5/8" I.D. x 5/32" thick.					3B43-307P1	6230	3	1		2		4	
		Bushing, eccentric.					3C7-169P1	6231		0		1		1	
		Bushing, catalin, ½" dia. x 5/16" long.					3B-288	6232		0		1		1	
		Bushing, brass nickel plated, ½" hex. x 3/8" long.					3C7-201	6233		0		1		1	
		Bushing, brass nickel plated, ½" dia. x 15/32" long.					105-5530P6	6234		0		1		1	
		Bushing, brass nickel plated, ½" dia. x ½" long.					105-5530P1	6235		0		1		1	

0 No spares furnished

TABLE IV LIST OF MANUFACTURERS

CODE NO.	MFR. PREFIX	NAME	ADDRESS
1	CBZ	Allen-Bradley Co.	Milwaukee, Wis.
2	CPH	American Phenolic Corp.	1830 S. 54th Ave., Chicago, Ill.
3		American Radio Hardware Co.	476 Broadway, New York, N.Y.
4	CHH	Arrow-Hart and Hegeman Elec. Co.	103 Hawthorn, Hartford, Conn.
5	CBX	Bodine Electric Co.	2254 W. Ohio St., Chicago, Ill.
6		Bryant Electric Co.	Bridgeport, Conn.
7		Cinaudagraph Corp.	2 Selleck St., Stamford, Conn.
8	CMC	Clarostat Mfg. Co. Inc.	285 N. Sixth St., Brooklyn, N.Y.
9	CD	Cornell-Dubilier Corp.	Hamilton Blvd., So. Plainfield, N.J.
10		Coto-Coil Co., Inc.	71 Willard St., Providence, R.I.
11		Electric Motor Corp.	1215 State St., Racine, Wis.
12		Federal Telephone and Radio Corp.	250 South St., Newark, N.J.
13		Fenwal, Inc.	Ashland, Mass.
14	CFI	Ford Instrument Co.	Lawson St. & Nelson Ave., Long Island, N.Y.
15	CG	General Electric Co.	Schenectady, N.Y.
16		General Electric Co. (Nela Div.)	Hoboken, N.J.
17		Globe Rubber Works	655 Atlantic Ave., Boston, Mass.
18	CHD	Hardwicke-Hindle, Inc.	40 Herman St., Newark, N.J.
19	CHS	Sylvania Electric Products, Inc.	60 Boston St., Salem, Mass. and Emporium, Pa.
20	CIR	International Resistance Co.	401 N. Broad St., Philadelphia, Pa.
21	CJC	Jones, Howard B.	2300 Wabansia Ave., Chicago, Ill.
22	CLF	Littelfuse, Inc.	4791 Ravenswood Ave., Chicago, Ill.
23		L-R Mfg. Co.	Torrington, Conn.
24		Morse, F.W.	301 Congress St., Boston, Mass.
25		Mu Switch Co.	Canton, Mass.
26	COC	Oak Mfg. Co.	1260 Clybourn Ave., Chicago, Ill.
27	COM	Ohmite Mfg.	4837 Flournoy St., Chicago, Ill.
28	CRP	Raytheon Manufacturing Co.	Seyon St., Waltham, Mass.
29	CRC	RCA Mfg. Co.	Harrison, N.J.
30	CAN	Sangamo Electric Co.	11th St. & Converse Ave., Springfield, Ill.
31	CFW	Sickles, F.W.	297 Main St., Springfield, Mass.
32	CSL	Solar Mfg. Co.	Bayonne, N.J.
33	CSF	Sprague Specialties Co.	No. Adams, Mass.
34	CSA	Stackpole Carbon Co.	1942 Tannery St., St. Mary's, Pa.
35	CUF	Ucinite Co.	459 Watertown St., Newton, Mass.
36	CGC	General Control Co.	243 Broadway, Cambridge, Mass.
37	CLL	Leland Electric Co.	Dayton, Ohio
38	CLR	Leach Relay Co., Inc.	5915 Avalon Blvd., Los Angeles, Calif.
39	CSQ	Spencer Thermostat Co.	Attleboro, Mass.
40	CAS	America Lava Corp.	Chattanooga, Tenn.
41	CMU	Micro-Switch Corp.	1 East Spring St., Freeport, Ill.
42		Allis Chalmers Mfg. Co.	Milwaukee, Wis.
43		Hagerty Co.	Cohasset, Mass.
44		Selectar Mfg. Co.	30 W. 15th St., New York, N.Y.
45		Fay and Scott Co.	Dexter, Maine
46		The Brown-Brockmeyer Co.	Dayton, Ohio
47	CW	Western Electric Co.	120 Broadway, N.Y., N.Y. & 100 Central Ave., Kearney, N.J.
48	CNA	National Company	61 Sherman St., Malden, Mass.
49		Lear Avia, Inc.	Piqua, Ohio
50		Stupakoff Cermaic Mfg. Co.	Hillview Ave., Latrobe, Pa.
51		Chandler, Evans Corp.	South Meriden, Conn.
52		Simplex Wire and Cable Co.	79 Sidney St., Cambridge, Mass.
53		S.S. White Dental Mfg. Co.	10 East 40th St., New York, N.Y.
54	CMG	Cinch Mfg. Co.	2335 West Van Buren St., Chicago, Ill.
55		Vibration Eliminator Co.	8-22 Astoria Blvd., Astoria, L.I., N.Y.
56	CYA	Alden Products Co.	117 N. Main St., Brockton, Mass.
57	CFA	Bussman Mfg. Co.	University and Jefferson St., St.Louis, Mo.
58		Chase-Shawmut Co.	Newburyport, Mass.
59		Stewart Stamping Corp.	621 East 216th St., New York, N.Y.
60		Belden Mfg. Co.	4647 Van Buren St., Chicago, Ill.
61		Atlantic India Rubber Works	1453 W. Van Buren St., Chicago, Ill.
62		General Motors Corp. (Packard Elec.) Div.	Warren, Ohio
63		Tyer Rubber Co.	Andover, Mass.
64	CEE	Thomas A. Edison Co., Inc.	West Orange, N.J.
65	CEL	Electronics, Inc.	125 Sussex Ave., Newark, N.J.
66		Lord Mfg. Co.	Erie, Pa.
67		Phelps Dodge Copper Prod. Co., Inca Div.	Fort Wayne, Indiana
68		Plastics Turning Co.	Leominster, Mass.
69		Pure Pac Co.	511 East 72nd St., New York, N.Y.
70		Minnesota Mining Co.	St. Paul, Minn.
71		Boston Woven Hose and Rubber Co.	29 Hampshire, Cambridge, Mass.
72	CSD	Struthers Dunn Inc.	1315 Cherry St., Philadelphia, Pa.
73		Gavitt Mfg. Co.	Brookfield, Mass.
74		Boston Insulated Wire and Cable Co.	65 Bay St., Dorchester, Mass.
75		Allied Control Co., Inc.	227 Fulton St., New York, N.Y.
76		Canfield Rubber Co.	Bridgeport, Conn.
77		Garlock Packing Co.	Elmira, N.Y.
78		Rome Cable Corp.	Rome, N.Y.
79		Flexo Wite Co.	Syracuse, N.Y.
80		General Cable Co.	420 Lexington Ave., New York, N.Y.
81		Wirt Co.	5221 Green St., Germantown, Pa.
82		Lafayette Radio Co.	110 Federal St., Boston, Mass.
83		General Radio Co.	Cambridge, Mass.
84		Amperite Co.	563 Broadway, New York, N.Y.
85		Selenium Corp. of America	1800 West Pico Blvd., Los Angeles, Calif.
86		National Carbon Co.	Cleveland, Ohio
87		Ohio Electric Co.	5902 Maurice Ave., Cleveland, Ohio
88		Bogue Electric Co.	West Paterson, New Jersey
89		The Murray Co.	27 Damrell St., South Boston, Mass.
90		Edwin L. Wiegand Co.	7500 Thomas Blvd., Pittsburgh, Pa.
91		B.F. Goodrich Co.	Akron, Ohio
92		Lee Engineering & Mfg. Co.	2025 West Wisconsin Ave., Milwaukee, Wis.
93		Federal Bearings Co., Inc.	West Poughkeepsie, N.Y.
94		Chrysler Corporation	Detroit, Michigan
95		American Flexible Coupling Co.	1800 Pittsburgh Ave., Erie, Pa.
96		John Oster Mfg. Co.	Genoa, Illinois
97		Thomas Flexible Coupling Co.	1938 So. Main St., Warren, Pa.
98		Cutler Hammer	Milwaukee, Wisconsin
99		Palmer Electric & Mfg. Co.	Wakefield, Mass.
100		Russell Electric Co.	370 W. Huron St., Chicago, Ill.
101		Guardian Electric Co.	1620 W. Walnut St., Chicago, Ill.
102		Fansteel Metallurgical Co.	Chicago, Ill.
103		Dillingham & Lewis	Indianapolis, Ind.
104		Morganite Brush Co.	3302 48th St., Long Island City, New York
105		P. R. Mallory	3029 E. Washington St., Indianapolis, Ind.
106		Gen. Motors Corp.(New Departure Div.)	Murden St., Bristol, Conn.
107		Norma Hoffmann Bearings Corp.	Stamford, Conn.

TABLE V

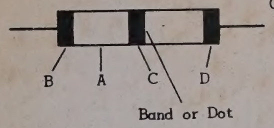
APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

RMA COLOR CODE FOR RESISTORS

COLOR	A 1ST DIGIT	B 2ND DIGIT	C CIPHERS
Black	-	0	.0
Brown	1	1	0
Red	2	2	00
Orange	3	3	000
Yellow	4	4	0000
Green	5	5	00000
Blue	6	6	000000
Purple	7	7	0000000
Gray	8	8	00000000
White	9	9	--

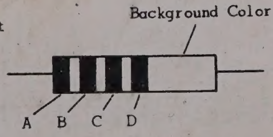
D - Tolerance Code:

Gold - 5%   Silver - 10%   Omit - 20%

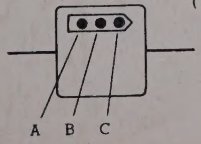


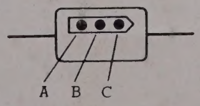
Original Color Arrangement
for
Axial Leads

New Color Arrangement
for
Axial Leads



USE ABOVE TABLE FOR CAPACITORS
(in $\mu\mu$fd.)



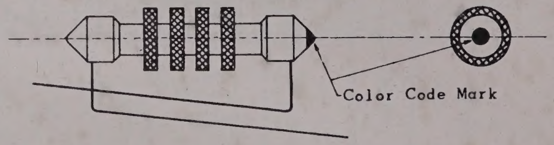


COLOR CODE FOR WIRING

A) Brown with green tracer - all AC connected to external source of supply.
B) Brown with red tracer - all AC isolated from external source of supply.
C) Red - DC circuits, any voltage
D) Green - all signal circuits

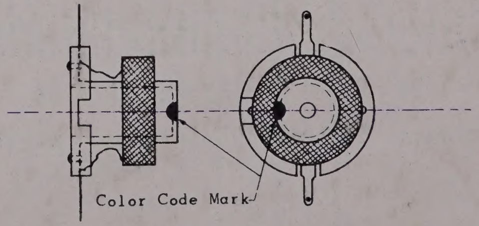
COLOR CODE FOR FOUR PI R.F. CHOKES

Orange	2.5 mh.
Red	5 mh.



COLOR CODE FOR SINGLE PI R.F. CHOKES

Red	5 mh.
Yellow	7.5 mh.
Green	10 mh.
Blue	25 mh.



Revised 1-29-44